A Bio-Physical Survey of Thirty Lower Fraser Valley Streams

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ABSTRACT

SCHUBERT, N.D. 1982. A bio-physical survey of thirty small lower Fraser Valley streams. Can. MS Rep. Fish. Aquat. Sci.

Bio-physical surveys were conducted on thirty small lower Fraser Valley streams during the autumns of 1977 and 1978. Spawning escapements and timing were noted for all salmon stocks, and coho (Oncorhynchus kisutch), chum (O. keta) and chinook (O. tshawytscha) salmon carcasses recovered on the spawning grounds were sampled for age, length, sex and egg retention. Watershed descriptions, including physical characteristics, stream flow summaries, and salmon spawning escapements were compiled from survey and departmental file data, and habitat problems and enhancement opportunities were noted where applicable.

Key words: lower Fraser Valley, escapements, timing, ages, watershed descriptions, enhancement opportunities.

Résumé

SCHUBERT, N.D. 1981. A bio-physical survey of thirty small lower Fraser Valley streams. Can. MS Rep. Fish Aquat. Sci. 000:000p.

Les saumons de remonte et le moment de la remonte furent notés pour tous les stocks de saumon. Les carcasses de saumon coho (Oncorhynchus kisutch), kéta (O. keta) et quinnat (O. tshawytscha) furent récupérées sur les frayères et échantillonnées pour la collecte des données sur l'âge, la longueur, le sexe et la rétention d'oeufs. Les descriptions du bassin hydrographique, y compris les caractéristiques physiques, les résumés des débits des cours d'eau et les nombre des saumons de remonte sont compilés à partir des données des études et des dossiers du Ministère. Les problèmes de l'habitat et les possibilités de mise en valeur sont mentionnés le cas échéant.

Mots clés: Bassin inférieur de Fraser, saumons de remonte, moment de la remonte, âges, descriptions du bassin hydrographique, possibilités de mise en valeur.

INTRODUCTION

The Salmonid Enhancement Program in British Columbia was initiated in 1977 with the objective of doubling the catch of Pacific salmonids by 1990. The enhancement strategy proposed for the Fraser River involves increased production of the major stocks of all species through a combination of enhancement and management actions designed to increase escapements to take advantage of presently underutilized spawning and rearing habitat. However, enhancement of many small stocks may be uneconomical, with the result that these stocks will be threatened with overexploitation if harvest rates are increased to take the more productive enhanced stocks.

The small streams of the lower Fraser Valley support runs of coho, chum and chinook salmon which are minor in terms of population size, but which may be of considerable importance in terms of genetic diversity and the aesthetic value of salmon spawning near major population centers. In order to identify these stocks and make recommendations to minimize the potential impact of large scale enhancement, a two year reconnaissance program was designed to survey thirty streams in the lower Fraser Valley (figure 1). The objective of this program was to collect relevant biological and physical data upon which appropriate management decisions and enhancement recommendations could be made. Some of the parameters assessed were the current escapement levels, spawning timing and distributions, and age, length and sex characteristics. In addition, an attempt was made to identify any production limiting habitat problems and to recommend enhancement opportunities.

This report documents the results of the study and includes brief watershed summaries for the thirty tributaries surveyed during 1977 and 1978. The report concludes with a discussion of enhancement options and recommendations for further studies in this geographical area.

MATERIALS AND METHODS

THE STUDY STREAMS

The purpose of this study was to survey all small streams located in the Fraser Valley below Hope which support small runs of coho, chum or chinook salmon and which were not being considered for enhancement during 1977 and 1978. Based on a review of the departmental escapement files (summarized by Marshall et al. 1979, 1980; Brown and Musgrave 1979), thirty streams were selected for the study (figure 1). Although the Upper Pitt River is a larger stream with a major coho population, it was included in the study to improve our knowledge of the salmonid resource and fish habitat of that tributary.

BIOLOGICAL SURVEY

Spawning ground surveys were conducted from November 1, 1977 to February 22, 1978 and from September 9, 1978 to March 9, 1979. The 1977-78 program commenced after completion of the chinook and early chum spawning, while the 1978-79 survey included the entire spawning period of all three species. The surveys were conducted by two two-man crews, and efforts were made to survey each stream every seven to ten days. During each survey, the crews walked the entire spawning area and water levels, turbidity, and weather conditions were recorded. Live and dead salmon were enumerated visually, and all carcasses were cut in two with a machete to avoid double counting. A minimum of ten percent of all chum carcasses, and all retrievable coho and chinook carcasses were measured for postorbital-hypural plate length and two, five and ten scales were taken from the preferred regions of chum, coho and chinook carcasses respectively for age analysis. The sex was recorded for all sampled carcasses, and a subsample of the females were cut open and examined for egg retention. The percent retention was based on an average fecundity of 2500 for coho, 2800 for chum and 5000 for chinook salmon (Wood et al., unpublished memorandum).

All scale samples were aged at the Vancouver scale laboratory and are designated by the Gilbert and Rich (1927) method. This method records the number of winters from the spawning of the parents until recovery as an upper case digit, and the number of winters from the spawning of the parents until the seaward migration of the juvenile as a subscript. When no subscript is reported, as with chum salmon, the fish migrated to sea shortly after emergence.

Spawning escapement estimates were made after the completion of spawning in each system. These estimates were derived subjectively and were based on the live and dead counts from each survey which were considered in conjunction with sighting conditions, physical stream characteristics, and carcass flushing rates, as indicated by the relative presence of previously chopped carcasses. For the purpose of these estimates, the spawner turnover rate for coho and chum salmon was assumed to be 11 to 13 days (Crone and Bond 1975, Koski 1966, Willis 1954) for coho and 10 days (Palmer 1972) for chum. All escapements reported in this study were derived independantly of those reported in the departmental escapement files, although in some cases other staff were provided with the study data.

STREAM DESCRIPTIONS

A brief summary of stream location, stream type, watershed activities spawning escapements, timing, and distributions, habitat problems, and enhancement potential was compiled for each stream.

Stream descriptions were based on the physical inventory data. Each stream was surveyed on foot from the mouth upstream to the limit of fish passage. In addition, areas above obstructions impassable to anadromous fish were investigated for inaccessible spawning and rearing habitat. Physical data describing stream width, depth, velocity, average gradient and streambed composition were used to develop general stream descriptions.

Stream lengths and watershed areas were calculated using National Topographic System 1:50,000 scale maps, and stream discharge data was obtained from Inland Waters Directorate stream flow summaries.

Five year escapement averages and timing of spawning were calculated from the departmental escapement files. The 1977 and 1978 timing and escapement estimates were derived from study data, with the departmental (fishery officer) estimates included in brackets when large discrepancies occurred between the two estimates. Spawning distributions, rearing habitat assessment, and obstruction identification were from study observations. Habitat problems were noted where applicable, and the summaries conclude with a brief description of enhancement potential for each stream.

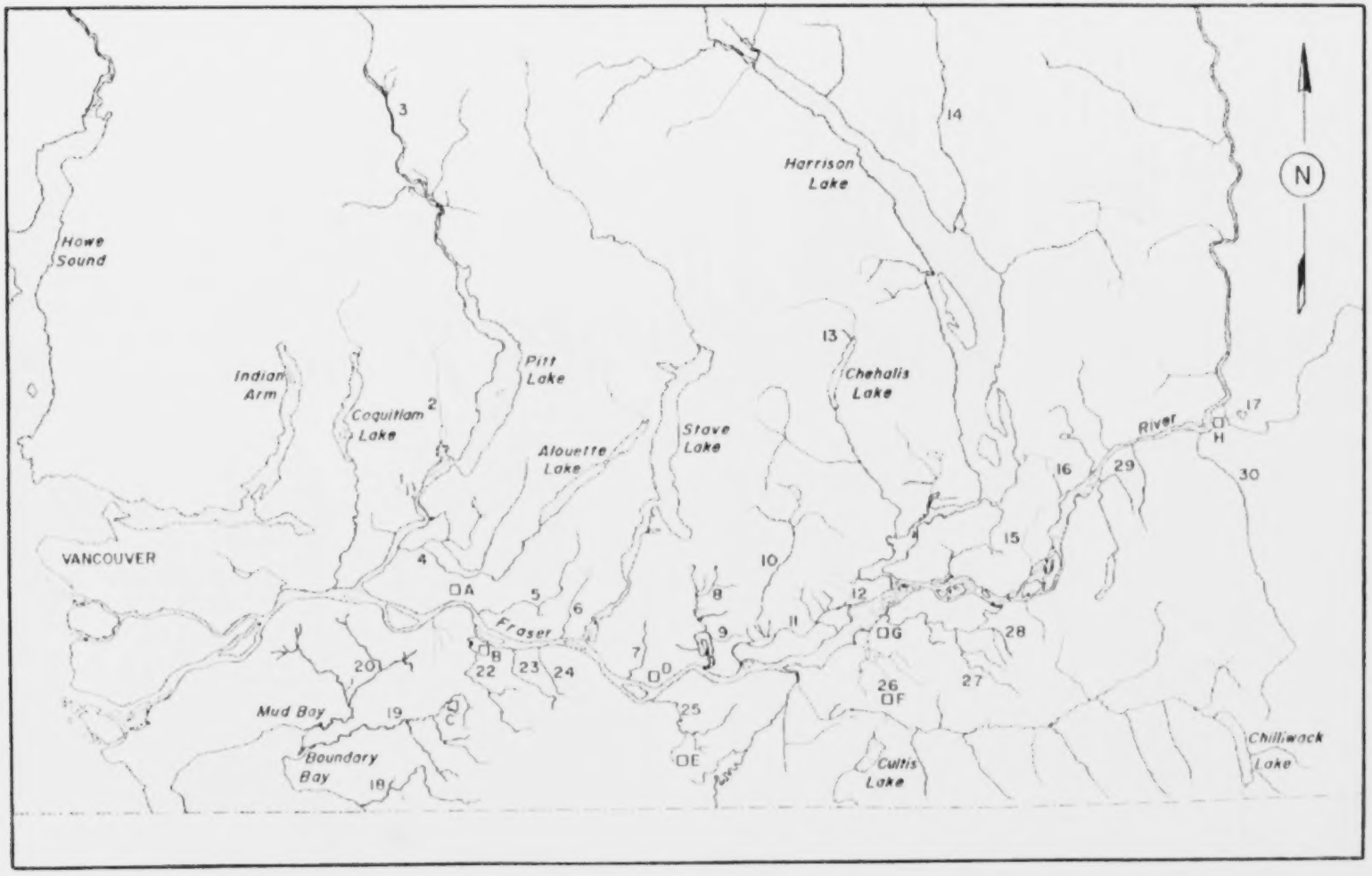

Figure 1. Study stream location map

LEGEND

1. McIntyre Creek
2. Widgeon Creek
3. Pitt River Upper
4. Alouette River
5. Kanaka Creek
6. Whonnock Creek
7. Silverdale Creek
8. Lugace (Bouchier) Creek
9. Chilqua (Thompson) Creek
10. Norrish (Suicide) Creek
11. Nicomen Slough
12. Siddle (Bells, Tatham) Creek
13. Coho Creek
14. Big Silver Creek
15. Maria Slough
16. Hicks Creek
17. Kawkawa Creek
18. Campbell River
19. Nicomekl River
20. Serpentine River
21. Yorkson (Jenkins) Creek
22. Salmon River
23. West Creek
24. Nathan (Beaver) Creek
25. Clayburn (Kelly) Creek
26. Luckakuck Creek
27. Elk Creek
28. Dunville Creek
29. Lorenzetta Creek
30. Silverhope Creek

A Haney
B Fort Langley
C Langley
D Mission
E Abbotsford
F Sardis
G Chilliwack
H Hope

Table 1. Summary of 1977 and 1978 coho salmon escapements to the study area streams. Bracketed figures are fishery officer estimates.

Stream	Estimated Escapement 1977	1978
Small Fraser River Tributaries		
Alouette River, North	300	250
Alouette River, South	450	250
Big Silver Creek	-	(75)
Chilqua Creek	25	25
Clayburn Creek	600	800
Cohoe Creek	1,500	(1,500)
Dunville Creek	450	300
Elk Creek	600	650
Hicks Creek	600	950
Kanaka Creek	50	100
Kawkawa Creek	600	400
Lagace Creek	50	50
Lorenzetta Creek	75	150
Luckakuck Creek	100	250
Maria Slough	0	0
MacIntyre Creek	400	375
Nathan Creek	700	1,100
Nicomen Slough	1,500	500
Norrish Creek	150	400
Salmon River	3,500	5,500
Siddle Creek	1,500	400
Silverhope Creek	25	25
Silverdale Creek	200	300
West Creek	300	200
Whonock Creek	250	350
Widgeon Creek	1,500	900
Yorkson Creek	150	75
TOTAL	15,575 (15,460)	15,875 (11,130)
Large Fraser River Tributaries		
Pitt River, Upper	7,500 (8,000)	17,500 (40,000)
Boundary Bay Streams		
Campbell River	500	1,500
Nicomekl River	3,500	600
Serpentine River	3,000	4,500
TOTAL	7,000 (7,300)	6,000 (6,100)

RESULTS AND DISCUSSION

BIOLOGICAL

Coho Salmon

Timing of Spawning. Spawning coho salmon were noted in all of the thirty streams surveyed during 1977 and 1978. Spawning commenced as early as late October in Campbell River and extended through March in Elk, Dunville and Hicks Creeks. Peak spawning generally occurred during December in most streams (Appendix 2).

The timing of each run was similar in the two survey years, however, during 1978 extremely cold weather in December and January caused ice formation on several streams and delayed the entry of any late spawners until the ice thawed. In the Salmon River, this produced a second spawning peak in mid-February.

Spawning Escapements. The 1977 and 1978 coho escapements to each stream are summarized in Table 1. Although large variations between 1977 and 1978 escapements were noted in a few streams (eg. Siddle, Salmon, Nicomekl), the escapement by area was similar in each year. A notable change occurred in the Upper Pitt River, where the spawning escapement was 2.3 times higher in 1978 than in 1977.

In many cases, departmental and survey escapement estimates differed significantly. This is attributable to variable sighting conditions and differences in survey effort. Overall, the 1977 departmental escapement estimates were comparable to study estimates, however in 1978 there were considerable discrepancies in the estimates for the Upper Pitt River and lower Fraser River tributaries. In the former case, the relatively large departmental escapement estimate may result from insufficient survey effort due to access problems. In the latter case, the discrepancy may be due to the fact that sub-district staff are required to submit their spawning ground survey reports at the end of the calender year. In 1978 those estimates omitted an influx of spawners which occurred during late January in Salmon River, and Hicks, Elk, Dunville, Lorenzetta, and Clayburn Creeks.

Collectively, the study streams (excluding the Boundary Bay streams) constitute an important proportion of the total Fraser River System coho run. During 1977 and 1978, these small lower Fraser River tributaries comprised 22.0% and 20.4% respectively of the total Fraser River coho escapement, and 29.8% and 27.5% of the total number of coho salmon spawning in streams tributary to the Fraser River downstream from Hope.[1] The Upper Pitt River contributed 10.4% in 1977 and 22.5% in 1978 of the total Fraser River coho run and is among the largest coho producers in the Fraser drainage.

Age, Length and Sex Composition. The age, length and sex composition of the coho salmon spawning ground recoveries is reported by stream in Appendix 2 and summarized by year in Table 2. These data are based on a total of 1716 coho sampled in 1977 and 2085 sampled in 1978.

Ages 4_3, 3_3, 3_2, and 2_2 coho salmon were recovered during the survey in the following percentages: 4.8, 0.3, 91.2, 3.8, in 1977 and 6.3, 0.4, 89.9, 3.4 in 1978. Age 3_2 coho were dominant in every stream, however age class structures varied considerably from stream to stream. For example, the Kawkawa Creek sample included all age classes, while Dunville Creek coho were entirely age 3_2. Age 4_3 coho were recovered in most streams, but were more frequent in the three Boundary Bay streams (5.2% and 16.4% in 1977 and 1978 respectively). Age 33 coho were recovered only in Kawkawa and Whonock Creeks. The only apparent habitat similarity between these systems is the presence of a small, relatively shallow lake in each. Age 2_2 or "jack" coho were recovered in most of the study streams.

Sex ratios also varied widely between and within streams over the two survey years. The overall sex ratio approximated 1:1 with 46.9% females recovered in 1977 and 52.8% females recovered in 1978. The sex composition in individual streams ranged from 17% to 81% females (Appendix 1). Overall, females were significantly ($p<0.05$) larger than males in both years, and age 3_2 and 4_3 females were larger than the respectively aged males, although this difference was not significant ($p<0.05$) in the latter group (Appendix 2). Age 3_3 coho were predominantly male, and age 2_2 coho were exclusively male.

The length composition appears to reflect the duration of ocean residence. There was no significant difference in length ($p<0.05$) between age 4_3 and 3_2 coho, each with a minimum of one marine year, or between age 3_3 and 2_2 coho, which spend only a few months in the ocean. In both survey years, age 4_3 and 3_2 coho were significantly ($p<0.05$) larger than age 3_3 and 2_2 coho.

Egg Retention. A total of 986 female coho carcasses from all survey streams were checked for egg retention during 1978. The average egg retention was 7.2% and 17.8% for the Fraser River and Boundary Bay tributaries respectively. The latter is high due to an unusually large pre-spawn mortality in the Serpentine River. The reason for this mortality is not known.

1. Based on escapement figures reported by Starr and Fraser (in prep.).

Table 2. Summary of 1977 and 1978 coho salmon age, mean postorbital-hypural plate length, and sex compositions.

	AGE:	4_3		3_3		3_2		2_2	SEX[1]	
	SEX:	M	F	M	F	M	F	M	Male	Female
1977	Mean Length(mm)	470	498	405	410	476	487	300	462	486
	Sample Size	27	35	2	1	609	580	50	912	804
	Frequency (%)	2.1	2.7	0.2	0.1	46.7	44.5	3.8	53.1	46.9
1978	Mean Length(mm)	453	476	346	-	452	481	290	439	479
	Sample Size	36	58	6	0	593	744	50	964	1101
	Frequency (%)	2.4	3.9	0.4	-	39.9	50.0	3.4	47.2	52.8

1. Includes both aged and regenerate samples.

Table 3. Estimated migratory peaks of study stream chum stocks at Upper Johnstone Strait and Cottonwood Drift, derived by backdating from peak dead recovery (see text).

Stream	Distance from Cottonwood Drift (km)	Peak Dead Recovery	Estimated Peak Migration at		
			Johnstone Strait	Cottonwood Drift	
Silverhope Creek	143	Mid October	Late August	Mid September	
Kawkawa Creek	148	Late October	Early September	Late September	EARLY
Big Silver Creek	145	Early November	Late September	Mid October	
Whonock Creek	50	Early November	Late September	Mid October	
Lagace Creek	69	Early November	Mid September	Mid October	
Silverdale Creek	60	Early November	Late September	Mid October	
Kanaka Creek	39	Early November	Late September	Mid October	
Alouette River	35	Mid November	Early October	Mid October	MIDDLE
MacIntyre Creek	40	Mid November	Early October	Late October	
Widgeon Creek	47	Late November	Mid October	Early November	
Chilqua Creek	69	Late November	Mid October	Early November	
Hicks Creek	114	Early December	Mid October	Early November	
Maria Slough	114	Early December	Mid October	Early November	
Nicomen Slough	76	Mid December	Late October	Late November	
Norrish Creek	76	Late December	Early November	Late November	
Worth Creek	76	Late December	Early November	Late November	LATE
West Creek	45	Early January	Mid November	Early December	

Chum Salmon

Migratory Timing. Fraser River chum salmon migrate to the Fraser River primarily from the north through Queen Charlotte and Johnstone Straits between mid-September and mid-November. These stocks are heavily exploited on their spawning migration by the Johnstone Strait, Point Roberts, and Fraser River commercial fisheries. The migratory timing of the major Fraser River chum stocks through these fisheries has been documented (Palmer 1972), however little data is available on the timing of the smaller study stocks. An attempt was made to estimate the timing of the study stocks through these fisheries in order to provide fisheries managers with a gross indication of which stocks may be impacted by changes in the fisheries. Migratory peaks at Johnstone Strait and Cottonwood drift (near Graveyard Reach in the lower Fraser River), were derived by backdating from the time of peak dead recovery in each stream, assuming that the rates of travel of the study stocks and the major stocks were identical. These data are reported in Table 3, and the method of derivation is summarized in Appendix 3(e). It is recognized that the backdating method can result in errors of a week or more in some years. However, the limited tag recovery data available for these stocks correspond well with the timing predicted by this method. Three Peterson disc tags recovered in the Alouette River (Palmer 1972) and one recovered in Nicomen Slough on December 7, 1978 were applied in Johnstone Strait and Upper Queen Charlotte Sound respectively within the predicted period (Table 3).

Timing of Spawning. Chum spawners were noted in nineteen of the thirty study streams. The timing of chum spawning was separated into early, middle and late timing segments (Table 3). The early timing stocks in Kawkawa and Silverhope Creeks began spawning in mid September and peaked by mid October. The middle timing group, which included the majority of the study stocks, began spawning in October and generally peaked between late October and late November. The late timing stocks, which included Nicomen Slough, Campbell River, and West, Norrish, and Worth Creeks normally peaked during December and spawning was completed by the end of January. Ground water was evident in most of the areas that support late timing chum.

The timing of the study area chum spawning was similar over the two years, with only minor variations attributable to environmental conditions and flow patterns.

Spawning Escapements. The 1977 and 1978 chum escapements to each stream are summarized in Table 4. Collectively, the study stocks comprise a minor segment of the total Fraser River chum resource. The 1977 and 1978 runs accounted for an estimated 7.5% and 5.8% respectively of the total Fraser River chum escapement.

Large variations were noted between the departmental and study escapement estimates, especially in some of the middle timing stocks. These differences were attributed to variations in sighting conditions and survey techniques.

Considerable differences were noted between the 1977 and 1978 study escapements for individual streams, particularly in those supporting middle timing stocks. Much of this variability can be attributed to changes in fishing pressure over the two years. During 1977, the Johnstone Strait, Point Roberts and Fraser River commercial fisheries were severely curtailed, resulting in an exploitation rate on Fraser River chums of approximately 7% (MacKinnon and Anderson, unpublished). During 1978, however, Fraser River chums were harvested at an estimated rate of 63%, resulting in the third largest catch since 1967.

Table 4. Summary of 1977 and 1978 chum salmon escapements to the study area streams. Bracketed figures are departmental escapement estimates.

Stream	Estimated Escapement 1977	1978	
Kawkawa Creek	350	300	EARLY
Silverhope Creek	25	250	
TOTAL	375 (370)	550 (460)	
Alouette River, North[1]	5,000	300	
Alouette River, South[1]	15,900	10,900	
Big Silver Creek	(75)	200	
Chilqua Creek	2,000	1,000	
Hicks Creek	250	25	
Kanaka Creek	1,000	300	
Logace Creek[2]	400	400	MIDDLE
Maria Slough	300	300	
MacIntyre Creek	1,000	25	
Silverdale Creek	300	150	
Whonock Creek	1,000	600	
Widgeon Creek	3,500	750	
TOTAL	30,725 (23,775)	14,950 (9,790)	
Campbell River	200	50	
Nicomen Slough	5,000	6,000	
Norrish Creek	3,500	6,500	LATE
Worth Creek	500	200	
West Creek	100	125	
TOTAL	9,300 (11,250)	12,875 (7,400)	

1. 1977 and 1978 escapements estimated by Blaney Creek SEP crew based on a 33% dead recovery (W. Faye, pers. comm.).
2. 1977 estimate is for tributary spawning only.

Table 5. Estimated 1977 and 1978 Fraser River chum escapements.

Timing[1]	Study Stocks 1977	(%Total)	1978	(%Total)	Fraser River Total[2] 1977	(%Total)	1978	(%Total)
Early	375	(0.9)	550	(1.9)	825	(0.2)	820	(0.2)
Middle	30,725	(76.1)	14,950	(52.7)	258,575	(58.1)	264,180	(66.0)
Late	9,300	(23.0)	12,875	(45.4)	185,750	(41.7)	135,355	(33.8)
TOTAL	40,400		28,375		445,150		400,355	

1. Separation of stocks by timing is from Harrison (unpublished).
2. From MacKinnon and Anderson (unpublished), except study escapements were used when applicable; mainstem spawners were excluded.

Table 6. Summary of 1977 and 1978 chum salmon age, mean postorbital-hypural plate length and sex compositions.

	AGE:	5		4		3		Combined [1]	
	SEX:	M	F	M	F	M	F	M	F
1977	Mean length (mm)	619	606	604	577	563	540	594	571
	Sample size	15	13	263	386	111	92	398	511
	Relative frequency (%)	12.6	10.5	29.9	43.9	1.7	1.5	43.8	56.2
1978	Mean length (mm)	623	597	593	572	552	536	586	565
	Sample size	38	31	792	1040	192	266	1052	1367
	Relative frequency (%)	8.1	11.3	33.6	44.1	1.6	1.3	43.5	56.5

1. Includes both aged and regenerate samples.

The total 1977 and 1978 chum salmon escapements to the Fraser River system and to the study streams are reported in Table 5. The 1978 total Fraser River chum escapement declined from the 1977 level by approximately 10%. A greater relative decline of 30% noted in the small study stocks was primarily a reflection of the severely depressed middle timing stocks. Since the 1978 fishery was targeted primarily on the middle timing group, it is apparent that smaller stocks are extremely sensitive to fisheries targeted on the strong runs in a mixed stock area. It is postulated that this sensitivity results from a narrow migrational timing range in these small stocks which makes them particularly vulnerable to any large fishery which coincides with their migrational peak. These data suggest that the small chum stocks may be particularly sensitive to overexploitation if the exploitation rate is increased to harvest enhanced stocks.

Age, Length and Sex Composition. The age, length and sex compositions of 1977 and 1978 chum salmon spawning ground recoveries are reported by stream in Appendix 3 and are summarized by year in Table 6. These data are based on a total of 909 chum sampled in 1977 and 2419 sampled in 1978.

Age 3, 4 and 5 year old chum salmon were recovered during the survey, with age 4 fish dominant in most streams. Overall, age 3, 4 and 5 chum returned in the following percentages: 23.1, 73.8, 3.2 in 1977 and 19.4, 77.7, 2.9 in 1978. The age composition of most stocks was similar over the two study years, however there was considerable variation in some streams. For example, in 1977, Chilqua and Worth Creek chum were predominantly age 5, while in 1978 age 4 dominated (Appendix 3c, 3d) reflecting a strong return from the 1974 brood year in these two systems. It is presumed that the age composition of the returns produced by each brood year would show less variability and that variations in the age compositions are therefore reflective of annual variations in spawner abundance and subsequent survivals.

The overall sex ratio was slightly skewed with 56.2% females in 1977 and 56.5% females in 1978. The peak dead recovery of females occurred before that of males in most streams. Five year old chum also tended to spawn and die off in the early part of the run in most streams. These two timing factors can bias the apparent size, sex and age information for a stock unless it is sampled over the entire spawning period.

In both 1977 and 1978, the overall mean post orbital-hypural plate length increased with age, and males were significantly larger than females ($p < 0.05$) within each age group (Appendix 3).

Egg Retention. A total of 691 female chum carcasses were inspected for egg retention during 1978. Based on an average fecundity of 2800, the total egg retention was 4.4%.

Chinook Salmon

Spawning Escapements and Timing. The 1978 escapements and timing of spawning of the study stream chinook stocks are reported in Table 7. These stocks were not surveyed during 1977 because of the late start of the survey. Single chinook carcasses were also recovered in Lagace, Serpentine, and Kawkawa Creeks.

Age, Length and Sex Composition. The age, length, and sex composition of 1978 chinook spawning ground recoveries is summarized in Table 8. With the exception of two recoveries in the Upper Pitt River, all 1978 chinook spawning ground recoveries showed an "ocean type" juvenile stage (i.e. the young spent less than one year in fresh water). Sample sizes were insufficient to provide statistically significant results, however it appears that age 4 was dominant in all systems and, in general, body size increased with age and ocean residency.

Upper Pitt River Chinook. Preliminary analysis of the Upper Pitt River chinook scale pattern shows a life-cycle with generally rapid freshwater growth, possibly reflecting a period of residence in Pitt Lake. The freshwater phase on the observed scales has a wide radius with over 20 circuli, a pattern which may be unique among the Fraser River chinook stocks. In view of the potential manageability of a stock with a scale pattern recognizable in the fishery, this characteristic should be quantified through radius measurements and circuli counts for all Fraser River chinook stocks.

Table 7. 1978 Chinook salmon spawning escapements and timing in Upper Pitt River, Maria Slough and Campbell River.

Stream	Estimated Escapement	Timing of Spawning		
		Start	Peak	End
Upper Pitt River	150	Early August	Mid August	Late September
Maria Slough	150	Late September	Early October	Late October
Campbell River	25	Mid October	Early November	Late November

Table 8. Age, length and sex composition of 1978 chinook salmon spawning ground recoveries. (Note: Initial figure is the mean postorbital-hypural plate length, in mm; the bracketed figure indicates the sample size).

Stream	AGE					SEX	
	2_1	3_1	3_2	4_1	5_2	Male	Female
Campbell River	-	549 (1)	-	681 (7)	727 (2)	680 (6)	666 (7)
Maria Slough	360 (2)	-	-	675 (9)	-	468 (3)	674 (9)
Upper Pitt River	-	-	450 (2)	765 (2)	-	607 (4)	-
Serpentine River	-	-	-	741 (1)	-	-	741 (1)
Lagace Creek	-	-	-	726 (1)	-	726 (1)	-
Totals	360 (2)	549 (1)	450 (2)	692 (20)	727 (2)	617 (14)	675 (17)
Frequency (%)	7.4	3.7	7.4	74.1	7.4	45.2	54.8

ENHANCEMENT OPPORTUNITIES AND RECOMMENDATIONS

Coho Salmon

The Fraser River coho stocks migrate through the lower river between August and November where they are harvested coincidentally with the pink, late sockeye and early chum stocks. If exploitation rates were increased after enhancement of these larger stocks, it is probable that virtually all of the coho study stocks would be subject to over-exploitation. Based on the assumption that this will occur, the enhancement recommendations discussed below (summarized in Table 9) are intended to maximize natural production in order to offset any declines which may occur at increased exploitation levels. They do not purport to include all available options for each stream nor are they intended to be the only available rehabilitative method. In some small streams with limited rearing habitat, extinction is probable, and escapements may be maintained only through extensive introductions from central hatchery facilities. In other cases, further study is required to determine the production limiting factors and the most effective rehabilitative techniques.

Fraser Valley Pumphouses. The Fraser Valley Dyking Board maintains a network of dykes and pumping facilities throughout the lower Fraser Valley as part of a regional flood control program. These facilities may have a severe impact on a number of the study area coho and trout populations (Table 10). Each spring, tributary flows are diverted through the pumps for a period which normally coincides with virtually the entire coho and trout smolt emigration. (Schubert, in prep.). Russell (1980) reported coho smolt mortalities of 25.8% to 31.4% at the Salmon River pumphouse, and coho mortalities of 53.5% in McLennan Creek, a similar facility with a rip-rapped outflow. An earlier study at Hatzic Slough (Anon. 1949) reported a 48.3% mortality for Kamloops trout and suggested that mortality was related directly to fish size. These juvenile losses were related to the study escapements to provide a crude assessment of the current impact on the study stocks (Table 10).

The precision of these estimates as indicators of the net benefit to be obtained from pumphouse removal is limited for three reasons: 1) Measurements of the Salmon River smolt migratory timing (Schubert, in prep.) indicate that a small but variable proportion of the annual emigration may occur prior to the onset of pumping each spring. The above figures would then tend to overestimate the actual losses. 2) These figures assume that the smolt-to-adult survival of the mortalities would otherwise have been equivalent to that of the survivors. However, in a study of the returns of adult coho in relation to the smolt size and time of release, Bilton (1978) reported a greater return from the larger May/June releases relative to the April releases. Since pumping normally commences in early May and may tend to select the larger migrants (Anon. 1949), this suggests that the more productive individuals are killed and the actual impact on adult production may be greater than indicated above. 3) Because the larger steelhead and cutthroat trout smolts may suffer a greater pumping mortality, the removal of this mortality factor may introduce a competitive advantage for trout at the expense of the predicted coho production increment.

Although further study would be required to accurately predict the benefits which would result from pump removal, the elimination of this mortality factor may be the most important single tool in increasing adult salmonid production in these streams. The following actions are recommended: 1) The actual value of these facilities in terms of flood protection should be determined. Some municipalities have enacted legislation to prevent building in areas below the 1948 flood levels, therefore many of these facilities may be protecting no more than marginal farmland. 2) If the removal of these facilities is not feasible, the replacement of at least one pump with a fish-safe model and the screening of the other pump intake bays is recommended. Pump replacement should be contingent upon present production levels and enhancement opportunities within each system and may not be feasible in many streams. In those cases, the pumping schedule could be modified to ensure that the pumps operate only when required. 3) Remedial actions in the Salmon River should begin immediately. As an interim measure, all smolts should be intercepted and transported to a release site below the pumphouse. However, because of the difficulty in capturing smolts and the high manpower requirements, this method should be considered as an interim measure only.

Headwater Stocking. The use of unutilized rearing areas above impassible obstructions is a promising technique currently being investigated in British Columbia by the Fish and Wildlife Branch. Headwater stocking opportunities have been identified in Silverhope and Kanaka Creeks, and to a lesser extent, in Alouette River and Big Silver Creek.

Table 10. Estimated adult production (catch plus escapement) and estimated pumphouse related production losses in five study streams. (In the absence of the pumps, the total stock size would be the sum of "Observed Stock Size" and "Estimated Pumphouse Loss").

Stream	Estimated Pumphouse Mortality	Estimated Stock Size[1] 1977	1978	Estimated Pumphouse Loss 1977	1978
Yorkson Creek	28.6%	750	375	300	150
Salmon River	28.6%	17,500	27,500	7,010	11,015
Hatzic System	48.3%	250	250	234	234
Clayburn Creek	53.5%[2]	3,000	4,000	3,452	4,602
Luckakuck Creek	28.6%	500	1,250	200	501
TOTAL		22,000	33,375	11,196	16,502

1. Extrapolated from escapement assuming an 80% exploitatin rate.
2. Rip-rapped outflow.

Table 9. Summary of enhancement opportunities identified in the study area streams.

	Pumphouse Modification	Headwater Stocking	Flow Control	Supplemental Feeding	Facility[1]	Instream Improvements[2]	Habitat Rehabilitation
Alouette River		x	x		x		x
Chilqua Creek	x					x	x
Clayburn Creek	x						x
Dunville Creek							x
Elk Creek							x
Hicks Creek			x			x	x
Kanaka Creek		x					x
Logace Creek	x						x
Luckakuck Creek	x			x			x
Maria Slough			x				x
Nicomen Slough			x		x	x	x
Norrish Creek						x	
Pitt River, Upper					x		
Salmon River	x						x
Silverdale Creek						x	x
Silverhope Creek		x				x	
West Creek						x	x
Yorkson Creek	x					x	x

1. Includes proposed and existing facilities
2. Primarily opportunities to create new habitat rather than rehabilitating damaged habitat.

Table 11. Potential production from headwater stocking of coho fry in two lower Fraser Valley tributaries.

Stream	Stream Length Above Obstruction	Estimated Smolt Yield/km[1]	Potential Adult Production[2]	Obstruction Removal	Donor Stock
Silverhope Creek	21.0 km	1782	5613	possible	limited
Kanaka Creek	9.5 km	1605	2287	not possible	limited

1. from Marshall and Britton (unpublished).
2. 15% smolt to adult survival.

The upper portions of Kanaka and Silverhope Creeks were surveyed during 1978 and appeared to have excellent rearing potential (Table 11). Silverhope Creek is felt to be the best prospect for headwater stocking because of higher potential production and easier resolution of access problems. Coho enhancement should be planned in conjunction with the Fish and Wildlife Branch who are currently stocking steelhead fry in this system.

Removal of the obstructions in Kanaka Creek may not be feasible, therefore headwater stocking would require either annual transport of adults over the obstruction or the operation of an incubation box. The rehabilitation of the three lower tributaries of Kanaka Creek would provide additional spawning habitat for colonization by the returning adults.

Headwater areas in the Big Silver Creek and Alouette River systems may be suitable stocking sites, especially for chinook salmon, however more detailed surveys are required to determine the potential of these areas.

Stream Improvement. The majority of the survey streams are located in moderately to intensively developed agricultural and residential watersheds. Fisheries conflicts within such watersheds generally arise from 1) Dyking and channelization for flood control; 2) Bank destabilization resulting from land clearance without the provision of a 'leave strip'; 3) Unrestricted movement of livestock through the creeks; 4) Deterioration of water quality from urban and agricultural runoff; 5) Extensive land clearing resulting in faster runoff patterns causing more frequent freshets and depressed summer flows. The latter is often aggravated by heavy licenced water withdrawal.

The proliferation of such problems may be symtomatic of the reactive approach by the Department of Fisheries and Oceans to minor habitat management problems. A possible means to minimize future conflicts may involve including the major user groups within each drainage in a cooperative watershed management and planning process. Such a scheme, however, will require a greater degree of coordination between the various fisheries agencies in order to define goals and priorities for each system.

A number of habitat problems are identified below. Suggestions for the resolution of those problems involve small programs, which may be most effectively implemented by the Special Projects or Public Involvement groups of SEP. It is emphasized that this list is incomplete. Virtually every study stream can benefit from rehabilitative programs in which public involvement should be a principle component.

Yorkson Creek is a small stream which suffers from low summer flows, channel degradation arising from subdivision construction, and an ongoing pumphouse problem. The system may benefit from instream improvements to the rearing habitat and gravel introduction above 93A Avenue.

Salmon River. Paish (1979, 1980) identified a number of habitat problems and suggested specific remedial actions such as culvert replacement, replanting streamside vegetation, fencing and bank stabilization. These recommendations should be evaluated by SEP and implemented where appropriate.

West Creek. A high riffle:pool ratio and low summer flows may limit coho production in West Creek. Recommendations: 1) Improvement of the riffle:pool ratio by pool creation throughout the creek; 2) Bank stabilization by the planting of streamside trees and shrubs and the restriction of cattle access below the 80th Avenue crossing; 3) Channel improvements in a 2 km section below 264th Street which was choked with logging debris in 1978.

Nathan Creek has a strong coho run, however local residents report stranding of juveniles in the upper reaches during low flow periods each summer. Fry salvage may be appropriate in those areas if flows cannot be maintained.

Clayburn Creek flows through ditched farm fields between the lower Clayburn and Wright Road crossings. Pool creation, bank stabilization, and replanting of streamside vegetation in this section is recommended as a means of expanding coho spawning and rearing habitat.

Stoney Creek is a major spawning area for Clayburn system coho salmon. In recent years, subdivision construction in the headwaters has removed much of the streamside vegetation, altered the channel geometry, and caused heavy siltation throughout the creek. Bank stabilization, gravel introduction, pool creation, replanting of protective streamside vegetation and resolution of water withdrawal problems are recommended as remedial measure.

Luckakuck Creek is a small groundwater fed stream which arises at a series of ponds within the town of Sardis. A combination of excellent overwintering habitat and the nearby labor pool in Sardis may make this an excellent prospect for a supplemental feeding program.

Dunville Creek. Such measures as vegetation replanting, pool creation, and bank stabilization are necessary to rehabilitate the spawning habitat in Dunville Creek.

Hicks Creek suffers from low flows and elevated water temperatures during the summer months. It is recommended that: 1) flow control from Hicks Lake be investigated; 2) the two small groundwater tributaries (Appendix 1) be expanded, undergo gravel introduction, debris removal, and bank stabilization, and 3) cattle access be restricted and streamside vegetation at the upper powerline crossing be replanted.

Siddle Creek. Instream work to improve coho spawning and rearing habitat is recommended in a 200 m section of both branches below the railroad crossing. Spawner access to the west branch can also be improved.

Norrish Creek. A side channel running from the canyon outflow to approximately 100 m above the CPR crossing was blocked in 1968. Since coho were observed spawning in the lower part of this channel in 1978, the channel should be reopened and gravel introduction and channel improvements implemented.

Chilqua Creek. Coho rearing would benefit from a rehabilitation of the headwater pools, and from an increase in the pool and cover habitat throughout the north branch.

Logace Creek may eventually benefit from rehabilitation techniques, but only after the stream flows stabilize following the cessation of logging in the eastern portion of the watershed.

Silverdale Creek. Rehabilitation of the east branch in order to improve groundwater percolation and expand the available spawning and rearing habitat may improve coho production from this system.

Slough Enhancement. Five sloughs provide spawning or rearing habitat for the study area coho stocks: Nicomen, Maria, Camp/Hope, Matsqui and Widgeon. With the exception of Matsqui and Widgeon these sloughs are former Fraser River side channels which have been dyked at the inflows resulting in reduced flows, heavy siltation, and accelerated aquatic plant growth. Very little is known of historic stock levels, however it is believed that some of these areas were once major chum producers (Palmer 1972). The existence of gravel deposits underlying the silt in many areas supports this assumption.

There is indirect evidence suggesting that these sloughs have become important coho rearing areas. An absence of summer flows in Elk Creek, Dunville Creek, and many of the smaller Nicomen Slough tributaries indicates that these stocks must rear elsewhere.

In order to optimize coho, chum, and pink production from these areas a detailed study should be designed to: 1) Assess the feasibility of manipulating flows, initially in conjunction with mechanical silt removal, to clear all available spawning gravel of silt; 2) Determine the optimum fall and winter flows which would be required to clear the gravel of silt deposited during the annual spring Fraser River back-up; 3) Determine the potential costs and benefits of flow control and silt removal; 4) Estimate the current rearing capacities of these sloughs and the degree to which that capacity is being utilized; and 5) Assess the probable effect of flow alteration on the current coho and trout rearing capacities.

Upper Pitt River. Salmonid stocks in the Upper Pitt River System include a major coho run, depleted chinook, chum, and steelhead runs, and an enhanced sockeye run. The chinook stock has declined sharply in recent years and should be targeted for immediate enhancement. A number of factors may favor a major facility approach in this system: 1) Ground and hotspring water sources have been identified in a number of benchland areas which may e suitable hatchery construction sites; 2) Unstable flow patterns resulting in part from clearcut logging practices have been associated with erratic coho, chinook, and chum escapements over the last twenty years. The declines in the chinook stock reflect an almost total loss of the Boise Creek and mainstem Pitt spawning populations, two areas which are susceptible to scouring at high flows. 3) Descrete harvesting of enhanced stocks may be feasible through a terminal fishery in Pitt Lake. (Chinook and coho enter the upper river in a fresh or silver-bright condition and would be of high commercial value); 3) The location of the system within the lower mainland would encourage the development of a strong sports fishery in Pitt Lake.

Chum Salmon

The proposed enhancement strategy for Fraser River chum salmon involves maximizing natural production while at the same time providing a large increment in production through artificial enhancement. As with coho, the analysis of enhancement opportunities is confined primarily to habitat rehabilitation opportunities which are intended to maximize natural production. Significant chum production increases can be expected from slough rehabilitation, however potential species interactions are complex and should be the subject of a detailed study.

The following is a summary of small stream chum enhancement opportunities identified during the program.

Chilqua Creek originates in a debris and silt choked series of upwelling pools. Channel excavation, gravel cleaning and replacement, and bank stabilization is recommended in this area. Preliminary improvements were affected during 1978.

West Creek is joined approximately 400 m upstream from the mouth by a 100 m long groundwater tributary. Expansion of the spawning area by channel excavation, gravel placement and bank stabilization is recommended. Bank armouring may be necessary due to inundation by the Fraser River each spring, and fencing is required to prevent cattle access. Similar improvements would be beneficial throughout the lower 2 km of West Creek.

North Nicomen Creek is a Nicomen Slough tributary with habitat problems similar to those discussed for West Creek. The expansion of the spawning area through channel excavation, silt removal, gravel cleaning and placement, and bank stabilization is recommended, especially in the pool areas near the railroad crossing. Like West Creek, this area is inundated each spring by Fraser River water, therefore bank armouring may be necessary. Fencing to restrict cattle access is also required.

Silverhope Creek. An old side channel with a flow control structure enters the Silverhope immediately above the Highway #1 crossing. In view of the limited available spawning habitat in this system, the reopening of and the addition of spawning gravel to this channel is recommended.

Nathan Creek historically supported a small, middle timing chum run which became extinct in the early 1960's. It may be appropriate to reestablish this run through fry introductions in conjunction with some lower river channel improvement work.

Silverdale Creek. The potential benefit of channel excavation and gravel placement in the ground water areas below Silverdale Road should be investigated.

CONCLUSIONS

1. The small streams of the lower Fraser Valley almost universally suffer extensive habitat degradation resulting from ongoing residential and agricultural development. An intensified habitat protection program coupled with cooperative planning involving the various user groups within each watershed may be the most effective mechanism by which such damage can be avoided in the future.

2. The cost effective resolution of many of the current small stream habitat problems will depend on volunteer labor coordinated by the Public Involvement group of SEP. However, it is emphasized that the activities of these groups must be specifically oriented toward the resolution of production limiting habitat problems, and any increment in production must be in keeping with the regional management goals.

3. A number of specific enhancement opportunities were identified which included stream rehabilitation and improvement, stocking, pumphouse modification, and artificial propagation. The similarity in timing of the study stocks with the major Fraser River stocks suggests that the successful implementation of these proposals will depend largely upon the management strategy developed for the harvest of the major enhanced stocks. If exploitation rates in the mixed stock areas are increased, small stream enhancement may be insufficient to prevent the extinction of many of the study stocks.

4. The estimation of spawning escapements from deadpitch data is subjective at best, particularly under conditions of limited visibility or survey effort. With the current emphasis on management to escapement, it is critical that escapements be estimated with a high degree of precision. In view of the large number of spawning stocks and the district manpower restrictions, the most suitable strategy may involve establishing accurate indexed escapement trends for specific critical stocks via Peterson disc tagging programs or permanent enumeration fences. These trends could then be extrapolated to less frequently surveyed runs with similar migratory timing.

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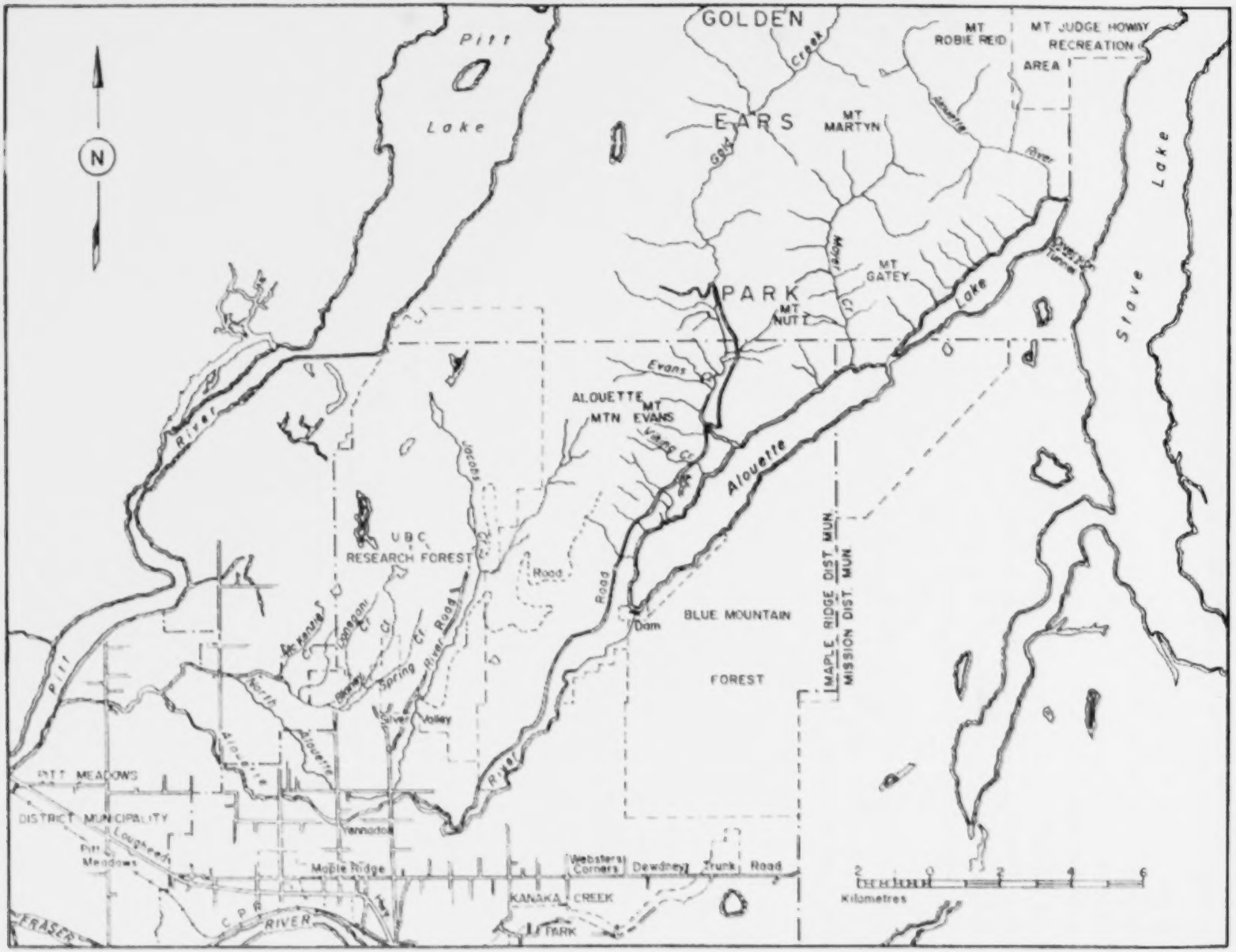
LEGEND FOR ALL MAPS

coho spawning x
chum spawning ..... o
chinook spawning ..... *


GOLDEN
MT ROBIE REID
MT JUDGE HOWAY RECREATION AREA
EARS
MT MARTYN
Pitt Lake
Gold Creek
Silverhope River
Stave Lake
MT GATEY
PARK
MT NUT
Evans Creek
Alouette Lake
ALOUETTE MTN
MT EVANS
Evans Ck
Alouette River
Jacobs Creek
UBC RESEARCH FOREST
Road
Dam
BLUE MOUNTAIN
FOREST
MAPLE RIDGE DIST. MUN.
MISSION DIST. MUN.
Hennessy Creek
Longhorn Ck
Spring Creek
River Road
Silver Valley
North Alouette
Alouette River
Pitt River
PITT MEADOWS
DISTRICT MUNICIPALITY
Pitt Meadows
Yennadon
Mobile Ridge
Websters Corners
Dewdney Trunk Road
KANAKA CREEK
PARK
C.P.R.
FRASER RIVER
N
Kilometres

ALOUETTE RIVER

LOCATION

Flows in a southerly direction for approximately 46 km, entering the Chatham reach of Pitt River.

STREAM TYPE

The Alouette system is formed by two main branches, the North and South Alouette Rivers, which drain a watershed of 335 km^2.

South Alouette River drains Alouette Lake (15.5 km^2 surface area) and has a total length of 25 km. The upper 9.5 km has a rapids/pool character and flows through a shallow, wooded valley. Below this area the gradient decreases and much of this section has been channelized and diked to prevent flooding of adjacent farmland. The lower 7.5 km is tidal and flows in a dyked channel through marsh and meadowland.

North Alouette River arises at an altitude of 1706 m and is joined in the upper 15 km by several tributaries as it flows through a densely wooded canyon. The stream emerges from the canyon 10 km upstream from the South Alouette confluence and forms a meandering channel across the lowlying plain, becoming slough-like in the lower 6 km. There are gravel deposits between 9.5 km and 6 km from the confluence, below which the channel has been dredged and dyked. Blaney creek joins the North Alouette in this section, approximately 2.4 km from the confluence.

OBSTRUCTIONS

There are a series of impassable rockfalls on the North Alouette beginning 11.2 km from the south Alouette confluence. On the South Alouette, a B.C. Hydro diversion dam at the outlet of Alouette Lake prevents further upstream fish passage.

WATERSHED UTILIZATION

Parts of the upper Alouette watershed which now comprise Golden Ears Provincial Park were logged between 1919 and 1929. In 1924, a diversion dam was built at the outlet of Alouette Lake as part of the Stave River hydroelectric program. No provisions were made in the dam for fish passage, consequently sockeye stocks which spawned in creeks tributary to Alouette Lake were erradicated.

Between 1954 and 1966 local municipalities channelized and removed gravel from the lower sections of both North and South Alouette Rivers as part of a flood control program and for use in road surfacing. This activity was coincident with a decline in coho and chum escapements and with a complete loss of pink salmon runs. In 1966 the Provincial government enacted a Gravel Removal Order to control further gravel removal. Between 1966 and 1976, there have been 11 controlled gravel removal permits issued. None have been issued since 1976.

In 1971, a minimum flow agreement with B.C. Hydro established a continuous flow of 2 cfs below the dam site and a minimum flow of 25 cfs at the 232 street bridge. Increased escapements since that time may indicate an improvement in stream conditions.

In 1979, the SEP Community Development group began development of a coho and chum salmon incubation and rearing facility on the South Alouette River. Production figures are not available at this time.

B.C. Hydro dam spillway at the outlet of Alouette Lake

A typical chum spawning area on the South Alouette River

FISHERIES RESOURCE

South Alouette chum salmon spawn in the middle section from approximately 7.6 km upstream to 15.0 km. Coho spawning is scattered from 14 km upstream to the dam and on the lower parts of several small streams tributary to this section. On the North Alouette chum spawn from 6 km to 7 km upstream, and coho spawn from 6 km up to the start of the canyon. High peak winter discharges causes scouring on both branches which has seriously reduced survival in some years.

In a study of fish distribution in the South Alouette River, Hartman (1968) reported coho and trout rearing throughout the stream with the highest density occurring among the large boulders and riffles in the upper sections. In past years, rearing has been severely limited by high temperatures associated with

low summer flows (Slaney, 1973), however this situation may have improved since minimum flows were established.

ENHANCEMENT OPPORTUNITIES

The Alouette River watershed has been the site of considerable enhancement effort to date. The Fish and Wildlife Branch is conducting an ongoing program of steelhead smolt releases and has identified further enhancement opportunities for anadromous trout (Griffith and Russell 1980); SEP Operations has maintained a pilot chum hatchery on Blaney Creek since 1972 (Banford and Bailey 1979); and the SEP Community Development Unit is operating a coho and chum hatchery at the Alouette River Correctional Center.

The most promising coho enhancement opportunity may involve the stocking of fry in the inaccessable reaches of North Alouette River, Blaney Creek, and Gold Creek. These areas lie primarily within park or research forest land and have excellent prospects for the longterm maintenance of habitat-related production values. A further ground reconnaissance is required to assess the coho or chinook rearing potential in Gold Creek, and to determine the potential impacts of the Alouette-Stave diversion tunnel on any introduced emmigrant population.

A dyked section of the North Alouette River, near the confluence

Table 1. Mean salmon escapements to the Alouette River System, 1962 to 1978.

Year	North Alouette		South Alouette	
	Coho	Chum	Coho	Chum
1962-1966	215	360	85	1,050
1967-1971	350	365	335	1,310
1972-1976	425	1,265	600	5,960
1977[1]	300	5,000	450	15,900 (7,000)
1978[1]	250	300	250	10,900 (6,000)

1. Chum estimates by W. Foye (pers.com.) based on 33% dead recovery; bracketed figure is the fishery officer escapement estimate.

Table 2. Timing of salmon spawning in the Alouette River System, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
		NORTH ALOUETTE RIVER		
Coho	1970-1976	Early November	Mid November	Mid December
	1977	Early November	Early December	Early February
	1978	Late October	-	Early February
Chum	1970-1976	Mid October	Mid November	Early December
	1977	Mid October	Mid November	Early December
	1978	October	Late October	Late November
		SOUTH ALOUETTE RIVER		
Coho	1970-1976	Early November	Early December	Late December
	1977	Early November	Early December	Early February
	1978	Late October	-	Early February
Chum	1970-1976	Late October	Early November	Early December
	1977	Mid October	Early November	Late December
	1978	Early October	Late October	Mid December

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Alouette River System coho salmon.

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean length (mm)	1978 N	1978 %
4_3	Male	575	1	6.7	-	0	-
	Female	-	0	-	-	0	-
3_2	Male	522	6	40.0	482	3	37.5
	Female	513	8	53.3	562	2	25.0
2_2	Male	-	0	-	285	3	37.5
Combined	Male	516	10	45.4	383	6	66.7
	Female	508	12	54.6	538	3	33.3

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Alouette River System Chum Salmon.

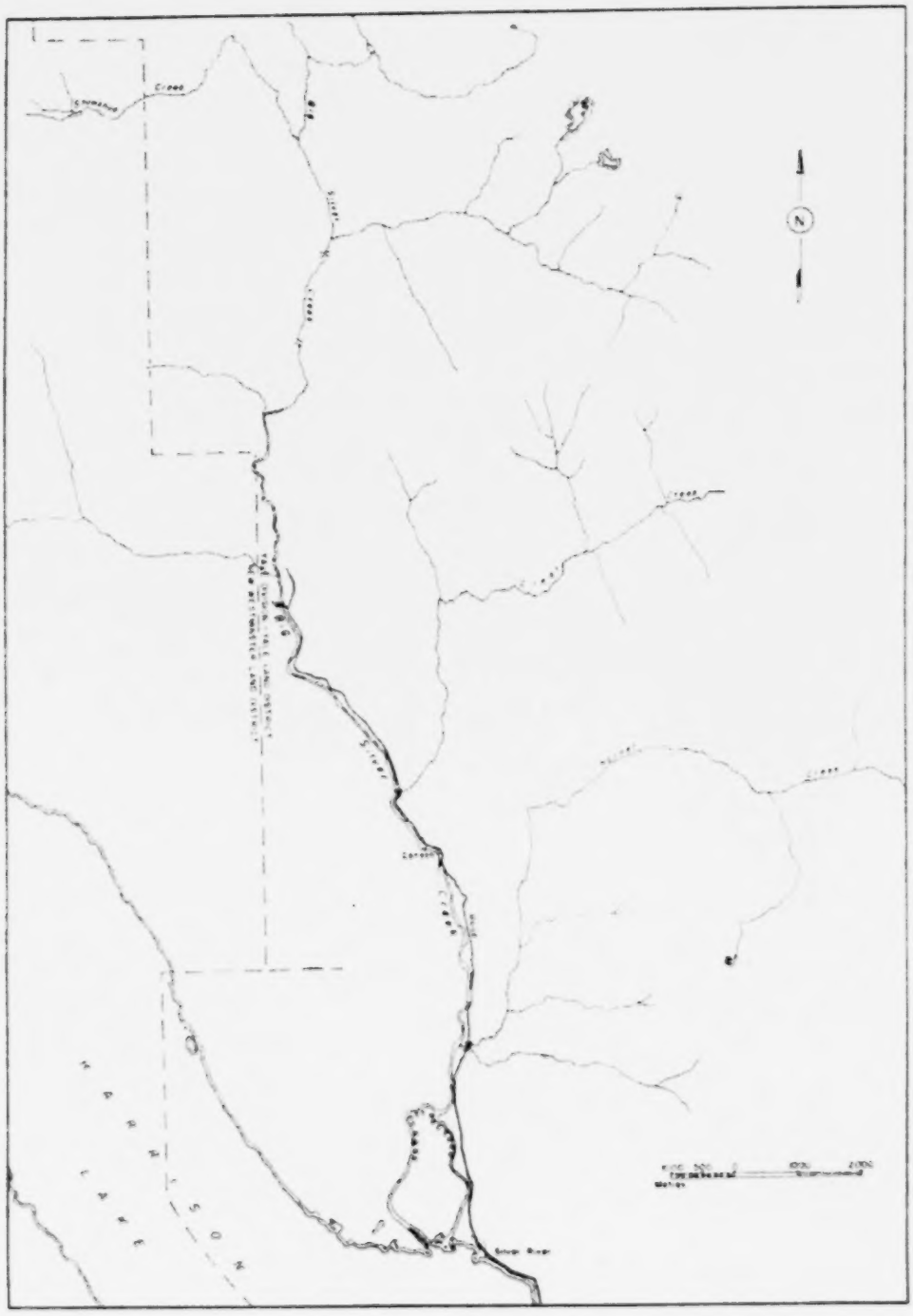
Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length (mm)	1978 N	1978 %
NORTH ALOUETTE RIVER							
5	Male	-	0	-			
	Female	-	0	-			
4	Male	634	17	53.1			
	Female	584	13	40.6			
3	Male	620	2	6.3		NONE SAMPLED	
	Female	-	0	-			
Combined	Male	627	25	48.1			
	Female	593	27	51.9			
SOUTH ALOUETTE RIVER							
5	Male	628	1	2.35	627	5	2.8
	Female	612	1	2.35	589	4	2.2
4	Male	626	8	18.60	592	72	40.2
	Female	575	17	39.5	568	71	39.7
3	Male	586	7	16.3	552	13	7.3
	Female	562	9	20.9	537	14	7.8
Combined	Male	607	17	34.7	586	92	50.3
	Female	570	32	65.3	564	91	49.7

Table 4(a). Monthly mean daily discharges in m^3/sec for the South Alouette River, metered at 232 Street (Station No. 08MH005).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	3.5	2.3	1.8	1.9	1.2	1.4	1.2	1.5	1.5	1.2	1.5	2.3	87.9(01/15)	0.7(11/11)
1975	2.7	2.0	2.1	1.1	0.9	0.7	0.5	0.9	0.7	2.5	19.4	17.2	93.2(12/04)	0.5(07/22)
1974	2.3	1.4	1.7	0.9	1.0	1.0	0.6	0.5	0.6	1.3	2.5	5.5	31.4(12/15)	0.4(09/10)
1973	2.3	4.7	4.2	2.3	1.2	1.0	5.4	0.8	1.0	0.8	1.7	4.0	68.0(07/13)	0.5(12/14)
1972	2.9													

Table 4(b). Monthly mean daily discharges in m^3/sec for North Alouette River, metered at 232 Street (Station No. 08MH006).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	4.6	2.4	2.7	2.9	3.3	2.7	2.2	2.0	1.7	1.3	2.6	5.0	26.9(12/26)	0.2(10/22)
1975	3.1	2.0	3.0	1.8	3.0	2.0	0.8	1.5	0.4	5.6	6.7	7.3	45.6(12/02)	0.2(10/01)
1974	6.7	5.5	5.5	3.3	4.3	2.9	2.8	0.7	0.4	0.4	4.7	4.7	39.9(02/03)	0.2(09/30)
1973	3.5	2.3	2.3	1.3	2.0	2.2	0.8	0.2	0.6	3.8	5.0	6.4	39.6(11/28)	0.1(09/05)
1972	3.9	5.5	5.5	4.1	3.1	2.1	3.2	0.4	1.9	0.5	3.7	8.6	58.3(07/12)	0.2(10/18)


N
HARRISON

BIG SILVER CREEK

LOCATION

Flows south for approximately 41 km entering the east side of Harrison Lake.

STREAM TYPE

Big Silver Creek arises at an elevation of 1600m and drains a mountainous watershed of 495 km^2. For the upper 26 km the creek forms a series of rapids and falls as it flows through a narrow, steep sided valley. The river width then increases and for 8 km assumes a rapids/pool form with a rubble substrate. It flows through an impassable canyon at 7 km and out into a large, deep pool at 6.5 km, below which it resumes a rapids/pool form. At 2.4 km the river splits into two main branches. The west branch is a series of broad, shallow riffles with a few isolated pools and contains excellent spawning gravel throughout. The east branch flows in a series of rapids, changing to a deep, slow moving run in the final 1.2 km.

Hornet Creek, the only major tributary below the canyon, is passable only for the lower 0.5 km.

OBSTRUCTIONS

A 3m high rockfalls located approximately 6.7 km upstream is impassable to migrating salmonids.

WATERSHED UTILIZATION

Extensive logging operations since 1920 have altered the flow regime of the system. Much of the timber along the valley bottom has been removed or burned and B.C. Forest Products has development plans through 1985 to log the upper parts of Clear, Spade, Shovel, Fir and Butter Creeks and areas along the mainstem north of Fir Creek. With the exception of logging, the remote nature of this watershed has precluded extensive development.

FISHERIES RESOURCE

Sockeye and chum salmon spawn throughout the west branch and at the outflows of pools and in back eddies in the upper 1.2 km of the east branch. Coho and chinook spawning, although concentrated in these areas, is also scattered throughout the system. Scouring resulting from unstable flows precludes heavy spawning on the mainstem.

Rearing habitat is very limited. Harrison Lake may be the rearing area for these stocks.

ENHANCEMENT OPPORTUNITIES

Unstable flows may be the primary production limiting factor in Big Silver Creek. If so, sufficient surface water is available for an incubation box facility, however further study is required to determine if the rearing capacity of the system and of Harrison Lake warrants the augmentation of the coho or chinook production. An estimated 8 km of stream habitat above the falls may be suitable for the stocking of chinook fry.

Extensive clear-cut logging and fire damage in the headwaters result in unstable flows.

Lower limit of chum spawning in the east branch of Big Silver Creek.

Table 1. Mean salmon escapements to Big Silver Creek, 1962 to 1978.

Year	Coho	Chum	Chinook	Sockeye
1962-1966	25	551	35	1,3181
1967-1971	200	832	55	5251
1972-1976	125	70	140	980
1978[3]	snowed out (75)	200	2 (25)	(1,500)

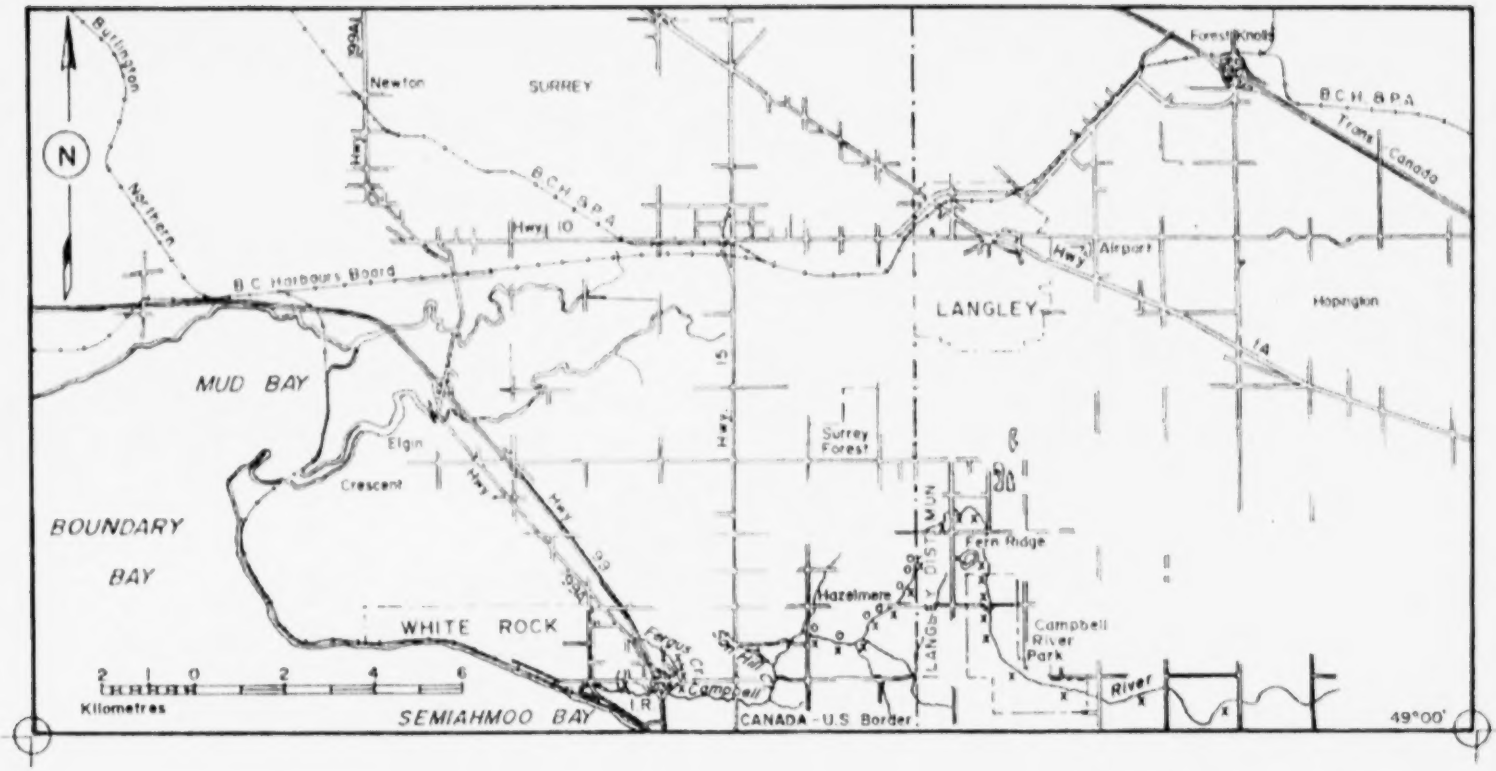
1. 4 years of data
2. 3 years of data
3. Bracketed figures are the fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Big Silver Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	September	November	January
	1978	Late November	Snowed out	Snowed out
Chum	1970-1976	October	October	November
	1978	Mid October	Early November	Mid December
Chinook	1970-1976	September	October	November
Sockeye	1970-1976	September	September	October

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1978 Big Silver Creek chum salmon.

Age	Sex	1978		
		Mean Length(mm)	N	%
5	Male	702	1	3.6
	Female	-	0	-
4	Male	612	6	21.4
	Female	580	13	46.4
3	Male	569	2	7.1
	Female	538	6	21.4
Combined	Male	612	9	32.1
	Female	567	19	67.9


N
Burlington Northern
Newton
SURREY
B.C.H. B.P.A.
Trans Canada
Forest Knolls
Hwy 10
B.C. Harbours Board
Hwy 1
Airport
LANGLEY
Hopington
14
MUD BAY
Elgin Crescent
Hwy 15
Surrey Forest
Hwy 99
BOUNDARY BAY
Fern Ridge
Hazelmere
DISTRICT LANDS
WHITE ROCK
Campbell River Park
Campbell River
Ferguson Creek
IR
2 1 0 2 4 6
Kilometres
SEMIAHMOO BAY
CANADA - U.S. Border
49°00'

CAMPBELL RIVER

LOCATION

Flows west for approximately 26 km entering Semiahmoo Bay south of White Rock.

STREAM TYPE

Campbell River drains large tracts of lowlying farmland encompassing an area of 64 km^2. The river is marshy for the upper 10 km, below which it flows in a meandering channel with a riffle-run development and excellent gravel deposits. Below 5 km the river becomes slough-like, and is estuarine in the lower 1.5 km.

Seven small tributaries join Campbell River, of which only Elgin and Fergus Creeks and a small unnamed creek located approximately 1.2 km upstream, contain spawning gravel.

OBSTRUCTIONS

No obstructions were observed during 1977 and 1978.

WATERSHED UTILIZATION

The Campbell River watershed was logged early in the century and a lumber mill and booming ground existed at the mouth until 1930. The watershed is extensively farmed and in 1959 the issuance of water permits was discontinued when the creek was declared fully subscribed for water use. This restriction was removed in 1969 and licences for irrigation and domestic use have since been granted. Commercial developments include three gravel pits (which have caused periodic siltation problems), a feed lot (which resulted in fecal contamination in 1975), and a turkey farm. There has recently been an acceleration in residential development with plans for eight subdivisions in the middle watershed area approved between 1976 and 1978.

FISHERIES RESOURCE

Coho spawn from 7 km to 15 km upstream and in the lower reaches of Elgin and Fergus Creeks and the unnamed creek 1.2 km upstream. Scattered spawning occurs throughout the upper reaches. Campbell River chum salmon spawn between 7 km and 10 km upstream.

Rearing potential, confirmed by scale analysis, is good, especially in the middle reaches where beaver dams and log jams provide optimum habitat. However, habitat is severely limited by low summer flows which, in the past, have resulted in high water temperatures and the stranding of juveniles.

ENHANCEMENT OPPORTUNITIES

A management study conducted in 1977 - 1978 by the Agricultural Resource Development Association, the Fish and Wildlife Branch, and the DFO Habitat Protection Division was to have included recommendations for enhancement. A report has yet to be issued.

Coho spawning habitat in the middle reaches of Campbell River

Marshy habitat in the upper reaches of Campbell River.

Table 1. Mean salmon escapements to Campbell River, 1962 to 1978.

Year	Coho	Chum	Chinook
1962-1966	390	45	-
1967-1971	420	90	-
1972-1976	4,040	290	-
1977	500	200	0
1978	1,500	50	25 (50)

1. Bracketed figures are the fishery officer estimates.

Table 2. Timing of salmon spawning in Campbell River, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Late October	Late November	Late December
	1977	Late October	Mid November	Mid January
	1978	Late October	Late November	Mid January
Chum	1970-1976	Early November	Late November	Early December
	1977	Mid November	Early December	Mid January
	1978	Mid November	Mid December	Mid January

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Campbell River coho salmon.

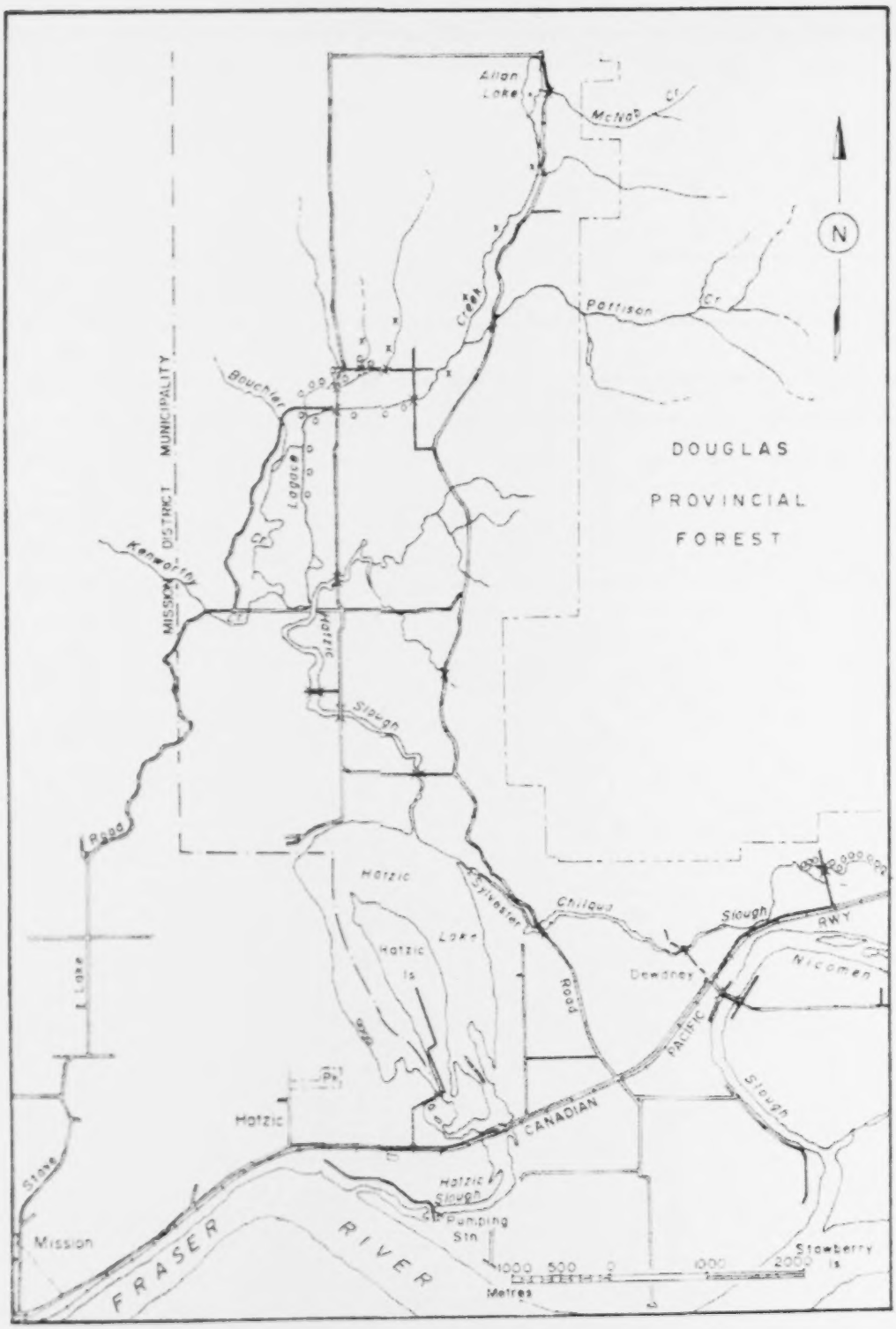
Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean length (mm)	N	%
4_3	Male	480	1	3.2	552	3	3.0
	Female	-	0	-	464	6	5.9
3_2	Male	513	14	45.2	464	45	44.6
	Female	465	16	51.6	492	46	45.5
2_2	Male	-	0	-	319	1	1.0
Combined	Male	505	17	47.2	463	71	49.7
	Female	471	19	52.8	484	72	50.3

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Campbell River chum Salmon.

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length (mm)	1978 N	1978 %
5	Male	-	0	-	-	0	-
	Female	-	0	-	-	0	-
4	Male	588	2	5.7	596	5	23.8
	Female	565	9	31.4	554	6	24.6
3	Male	574	12	34.3	569	2	9.5
	Female	535	10	28.6	533	8	38.1
Combined	Male	576	14	42.4	589	7	33.3
	Female	549	19	57.6	542	14	66.7

Table 4. Monthly mean daily discharges in m^3/sec for Campbell River, metered 4 km from the mouth (Note - '-' indicates incomplete readings for that month) (Station No. 08MH059)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1964	3.0	1.1	2.2	1.0	0.5	0.2	0.2	0.1	0.2	-	-	-	-	0.0 (09/12)
1963	1.7	1.9	1.0	1.0	0.7	0.2	0.3	0.2	0.1	0.2	2.3	4.0	14.2(12/23)	0.1(09/30)
1962	1.6	1.0	1.0	0.8	0.6	0.2	0.1	0.1	0.1	0.3	1.0	1.3	3.8(01/03)	0.1(07/12)
1961	-	-	-	-	0.9	0.3	0.2	0.1	0.2	0.3	0.9	1.9	-	-


Allan Lake
McNab Cr.
Pattison Cr.
Creek
N
DOUGLAS
PROVINCIAL
FOREST
Boucher
Lagace Cr.
MISSION DISTRICT MUNICIPALITY
Kenworth
Hatzic
Slough
Hatzic
Lake
Hatzic Is.
Silvester Road
Chilqua
Slough
Dewdney
Nicomen Slough
RWY
PACIFIC
CANADIAN
Hatzic
Hatzic Slough
Pumping Stn
Mission
FRASER RIVER
Stave Lake
Strawberry Is.
1000 500 0 1000 2000
Metres

CHILQUA (THOMPSON) CREEK

LOCATION

Flows west for approximately 2.5 km entering Chilqua Slough 3 km east of Hatzic Lake.

STREAM TYPE

Chilqua Creek is a low gradient, groundwater system which drains approximately 1.4 km^2 of farmland. The lower mainstem and the south branch, which joins 1 km upstream, are marshy throughout. The north branch originates in a series of upwelling pools and flows for much of its 1.5 km length in a drainage ditch thickly overgrown with trailing blackberry. Stream type is typically riffle/run with a sand/pebble substrate.

OBSTRUCTIONS

No obstructions were observed in 1977 and 1978. However, all migrating salmonids must pass through the Hatzic Lake Pumping Station. The effect of this facility on salmonid migration was discussed in the text.

WATERSHED UTILIZATION

Chilqua Creek flows entirely through farmland and has been channelized throughout the upper 1.5 km.

FISHERIES RESOURCE

Chilqua Creek chum and coho salmon spawn throughout the north branch.

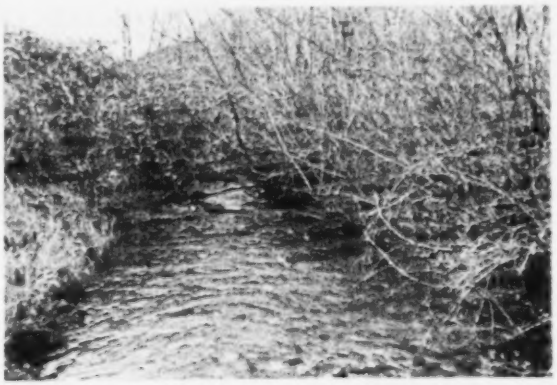
Rearing potential is limited by a lack of pools throughout much of the creek.

ENHANCEMENT OPPORTUNITIES

Chilqua Creek arises in a silt and debris-choked series of upwelling pools. Bank excavation and stabilization, silt and debris removal, and gravel placement are recommended in order to improve the spawning habitat in this area.

Any coho enhancement in this stream should be contingent upon the resolution of the Hatzic Slough pumphouse problem. Opportunities for enhancement through pool creation in the north branch should be investigated.

These upwelling pools in the headwaters of Chilqua Creek are heavily used by chum spawners.



Most of the north branch flows in a thickly overgrown drainage ditch.

Table 1. Mean salmon escapements to Chilqua Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	35	25
1967-1971	65	475
1972-1976	45	385
1977	25	2000
1978	25	1000

Table 2. Timing of salmon spawning in Chilqua Creek, 1970 to 1978.

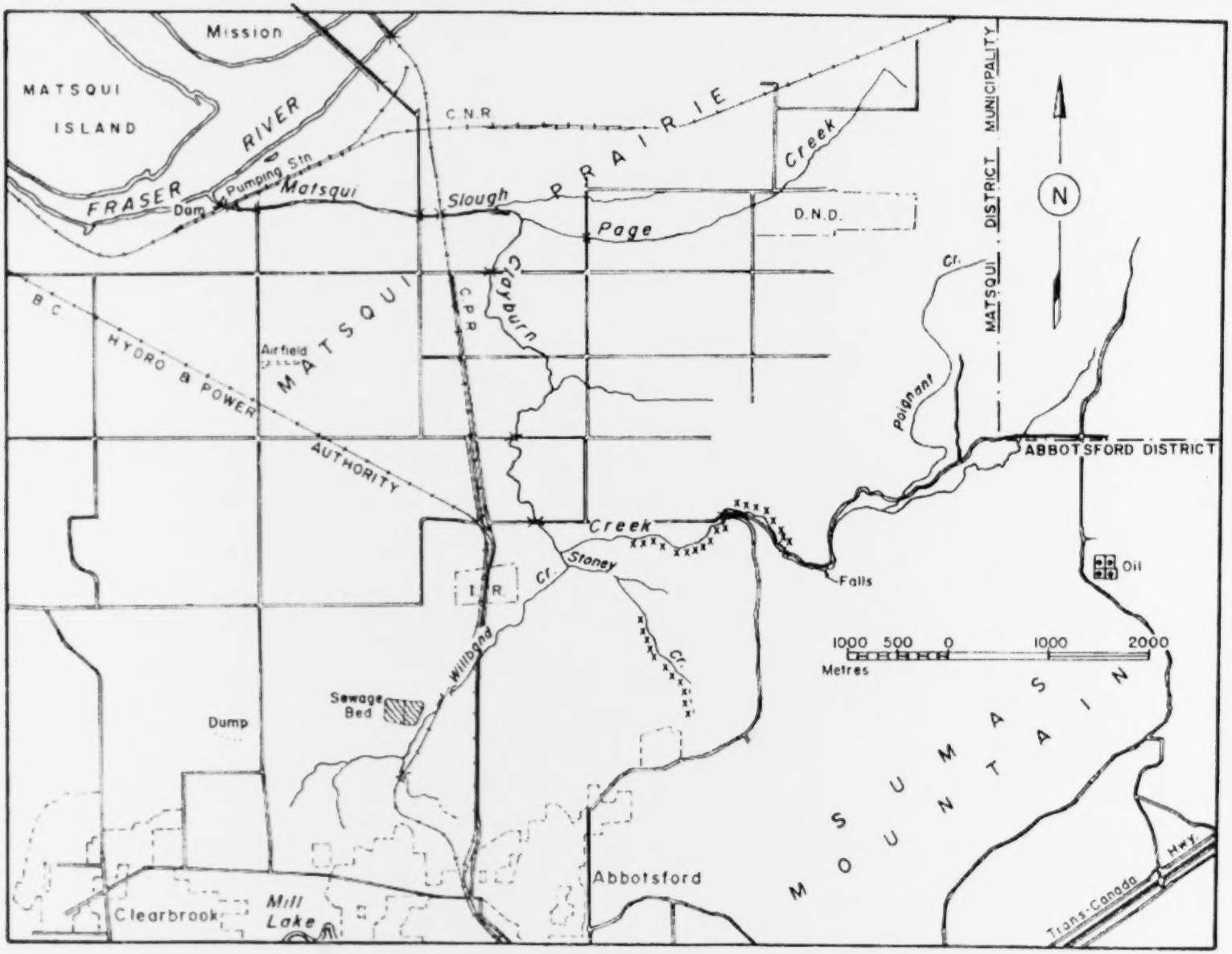
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	November	December	January
	1977	Early November	-	Early January
	1978	Mid November	Late December	Late January
Chum	1970-1976	October	November	December
	1977	Early November	Mid November	Early December
	1978	Early November	Mid November	Late December

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Chilqua Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
4_3	Male	-	0	-	454	1	100
	Female	-	0	-	--	0	--
3_2	Male	407	1	20.0	--	0	--
	Female	493	2	40.0	--	0	--
2_2	Male	315	2	40.0	--	0	--
Combined	Male	390	4	66.7	440	1	20.0
	Female	493	2	33.3	436	4	80.0

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Chilqua Creek chum salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
5	Combined	-	0	-	--	0	--
4	Male	595	9	10.3	580	59	29.8
	Female	575	7	8.1	565	114	57.6
3	Male	553	38	43.7	552	3	1.5
	Female	538	33	37.9	535	22	11.2
Combined	Male	561	47	54.0	579	63	31.5
	Female	544	40	46.0	561	137	68.5


Mission
MATSQUI
ISLAND
FRASER
RIVER
Dam
Pumping Stn
Matsqui
Slough
C.N.R.
PRAIRIE
Creek
Page
D.N.D.
MATSQUI DISTRICT MUNICIPALITY
N
B.C.
HYDRO & POWER
AUTHORITY
Airfield
MATSQUI
C.P.R.
Clayburn
Cr.
Poignant
ABBOTSFORD DISTRICT
Creek
Stoney
Cr.
I.R.
Falls
Oil
1000 500 0 1000 2000
Metres
Willband
Cr.
Sewage Bed
Dump
MOUNTAIN
SUMAS
Abbotsford
Clearbrook
Mill Lake
Trans-Canada
Hwy

CLAYBURN (KELLY) CREEK

LOCATION

Flows in a northerly direction for approximately 13 km entering Matsqui Slough north of Abbotsford.

STREAM TYPE

Clayburn Creek and its two major tributaries, Stoney and Willband Creeks, drain an area of approximately 52 km^2. In the lower 5.5 km Clayburn Creek is confined to drainage ditches flowing through exposed farmland. Above 5.5 km there is a progressive increase in slope. The creek is riffle/pool between 5.5 km and 7 km, then changes to rapids/pool and is impassable beyond 8.5 km upstream.

Stoney and Willband Creeks join Clayburn Creek approximately 5 km upstream. The latter is slough-like throughout and has little value as a salmonid producer. Stoney is a small creek with a coarse gravel substrate. Subdivision development has removed much of the riparian vegetation from this creek, and observations during 1977 indicate that lethal summer temperatures are common.

OBSTRUCTIONS

There are a series of impassable rockfalls 8.5 km upstream. Also, all migrating salmonids must pass through the Matsqui Slough Pumping Station. The effect of this facility on salmonid migration was discussed in the text.

WATERSHED UTILIZATION

The Clayburn Creek watershed has historically been developed for agriculture. Water withdraw problems may exist in the lower 5.5 km.

The Stoney Creek headwaters are undergoing extensive subdivision construction. Riperian vegetation removal has resulted in extensive erosion which has severly damaged the available spawning and rearing habitat.

Willband Creek receives the outflow of the Matsqui District primary sewage treatment plant.

FISHERIES RESOURCE

In Clayburn Creek heavy spawning occurs from kms 5.5 to 7.0. Above km 7.0 the substrate is rubble and spawning is scattered.

In Stoney creek, spawning is heavy throughout. During 1977 and 1978 up to half of the Clayburn escapement spawned in Stoney Creek.

Rearing potential in this system is questionable. All protective stream side cover has been removed in the lower 5.5 km and much of this area is channelized. In addition, upper Clayburn Creek and Stoney Creek are subject to low summer flows (table 4). Minnow trapping indicates there is a large indigenous trout population, however, no coho were captured.

ENHANCEMENT OPPORTUNITIES

All enhancement activities should be planned in conjunction with the resolution of the Matsqui Slough Pumphouse problem. Rehabilitative efforts should include bank stabilization, gravel introduction, pool creation, replanting streamside vegetation throughout Stoney Creek, and in the mainstem between the lower Clayburn and Wright road crossings.

Excellent coho habitat in the middle reaches of Clayburn Creek.

Altered channel geometry which is typical of the habitat destruction caused by subdivision construction in the headwaters of Stoney Creek during 1978.

Table 1. Mean salmon escapements to the Clayburn Creek System, 1962 to 1978.

Year	Coho	Chum
1962-1967	150	-
1968-1971	187	-
1972-1976	488[1]	-
1977[2]	600 (350)	-
1978[2]	800 (260)	(25)

1. 4 years of data
2. Bracketed figures are the fishery officer estimates.

Table 2. Timing of salmon spawning in Clayburn Creek, 1970 to 1978.

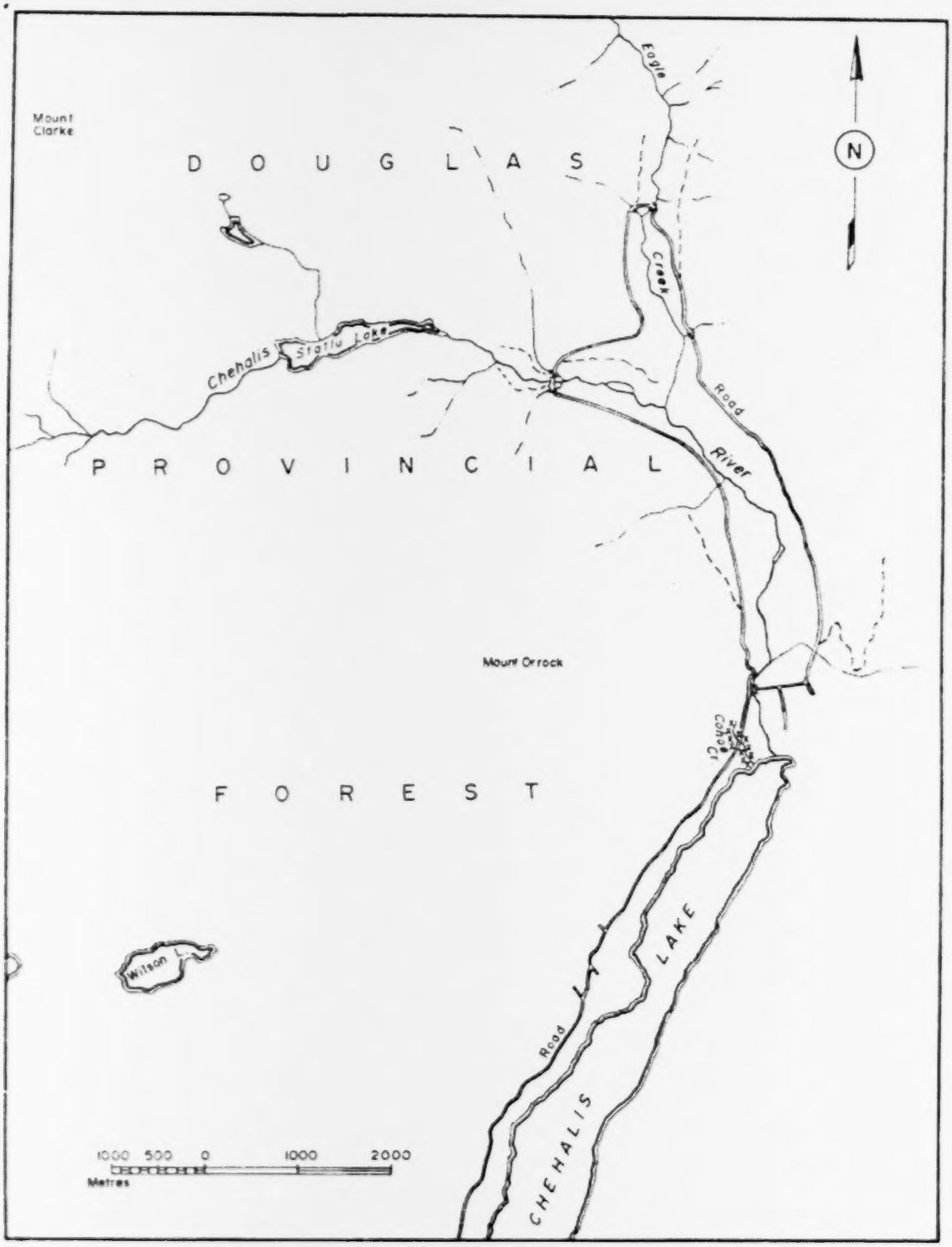
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Mid November	Mid December	Mid January
	1977	Early November	Late December	Mid February
	1978	Late November	Late December	Late February

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Clayburn Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
4_3	Male	-	0	-	414	1	2.0
	Female	555	1	1.4	457	1	2.0
3_2	Male	478	31	41.9	428	22	44.0
	Female	489	40	54.0	470	25	50.0
2_2	Male	343	2	2.7	309	1	2.0
Combined	Male	465	38	42.7	434	33	45.8
	Female	493	51	57.3	467	39	54.2

Table 4. Monthly mean daily discharges in m^3/sec for Clayburn Creek, metered (a) immediately below the Willband Creek confluence (Station No. 08MH068) and (b) 0.3 km east of the Clayburn townsite (08MH049). Note: '-' indicates no record for that month.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
(a)														
1971	-	2.8	2.1	1.7	0.8	-	-	-	-	-	-	-	6.8(01/27)	-
1970	2.0	1.5	1.1	1.4	-	-	-	-	0.5	0.6	-	-	-	-
1963	1.9	1.5	1.3	1.7	-	-	-	-	0.2	0.6	3.0	2.8	7.6(11/27)	0.2(09/01)
1962	3.1	1.7	1.3	1.3	-	-	-	-	-	0.9	2.7	2.5	7.0(12/30)	0.4(09/21)
(b)														
1962	1.0	0.9	0.4	0.4	-	-	-	-	0.1	0.3	0.7	0.8	1.3(01/03)	0.02(09/01)
1961	1.1	1.4	0.1	0.4	-	-	-	-	0.1	0.2	0.4	0.9	1.6(01/11)	0.05(09/10)


Mount Clarke
D O U G L A S
P R O V I N C I A L
F O R E S T
Eagle
Creek
Chehalis
Statlu Lake
Road
River
Mount Orrock
Wilson
Road
CHEHALIS
LAKE
N
1000 500 0 1000 2000
Metres

COHOE CREEK

LOCATION

Flows in a southerly direction for approximately 0.7 km entering the northwest end of Chehalis Lake.

STREAM TYPE

Cohoe Creek is a small groundwater system which flows in a two meter wide channel through a second growth deciduous forest. The creek arises at a large pool and has a riffle/pool form with excellent gravel deposits in the lower 0.5 km. Flow is intermittant during the summer months.

OBSTRUCTIONS

No obstructions were observed during 1977 and 1978.

WATERSHED UTILIZATION

Timber adjacent to the stream was logged in 1963 by Canadian Forest Products and second growth is now well established.

FISHERIES RESOURCE

Coho spawning is distributed over the lower 0.5 km. Rearing is limited by intermittent summer flows.

ENHANCEMENT OPPORTUNITIES

The limited rearing habitat in Cohoe Creek indicates Chehalis Lake may be the primary nursery area for this stock. If an assessment of the lake rearing capacity indicates that this habitat is underutilized, Cohoe Creek would be a suitable incubation box site.

Upwelling pool near the source of Cohoe Creek.

Cohoe Creek is typically shallow with few pools. This section was almost dry in early fall 1978.

Table 1. Mean salmon escapements to Cohoe Creek, 1962 to 1978.

Year	Coho
1962-1966	400
1967-1971	460
1972-1976	690
1977[1]	1500 (1200)
1978[1]	snowed out (1500)

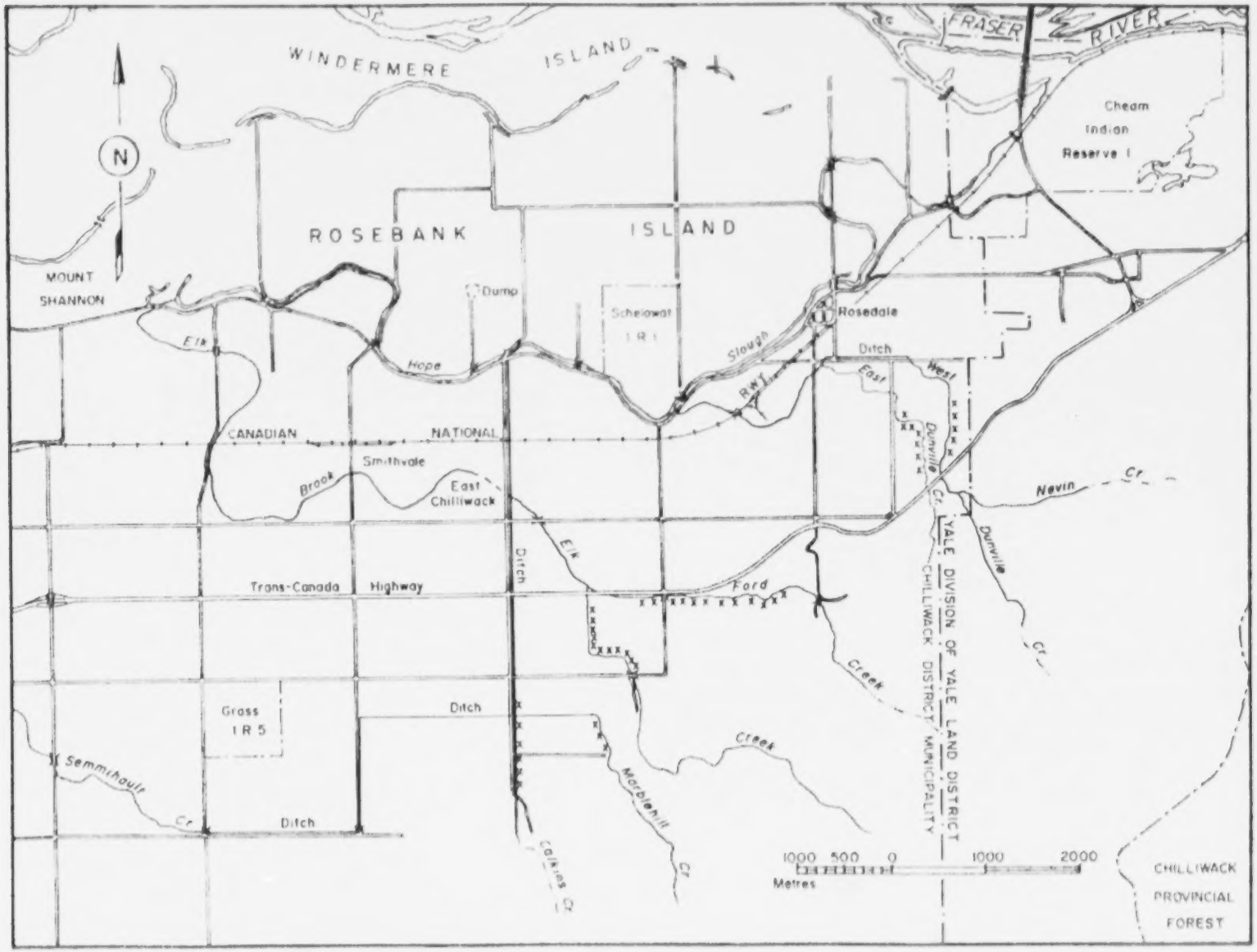
1. bracketed figures are from the fishery officer escapement files.

Table 2. Timing of salmon spawning in Cohoe Creek, 1970 to 1977.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	November	December	January
	1977	Early November	Early December	Late January

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 Cohoe Creek coho salmon.

Age	Sex	1977		
		Mean Length(mm)	N	%
4_3	Male	445	1	1.8
	Female	485	2	3.6
3_2	Male	486	29	52.7
	Female	492	23	41.8
2_2	Male	-	0	-
Combined	Male	484	32	51.6
	Female	489	30	48.4


WINDERMERE ISLAND
FRASER RIVER
Cheam Indian Reserve 1
ROSEBANK ISLAND
N
MOUNT SHANNON
Dump
Schelowat I.R. 1
Rosedale
Slough
Ditch
East
West
Elk
Hope
Dunville Cr.
Nevin Cr.
CANADIAN NATIONAL
Smithvale
Brook
East Chilliwack
Trans-Canada Highway
Ford
Creek
YALE DIVISION OF YALE LAND DISTRICT
CHILLIWACK DISTRICT MUNICIPALITY
Grass I.R. 5
Semmihoult Cr.
Marblehill Cr.
Collins Cr.
1000 500 0 1000 2000
Metres
CHILLIWACK PROVINCIAL FOREST

DUNVILLE CREEK

LOCATION

Flows in a northerly direction for approximately 6.6 km entering Hope Slough east of Chilliwack.

STREAM TYPE

Dunville Creek is a small stream (19 km^2 drainage area) which arises in the Skagit Mountains and flows from the mountainside onto the Fraser River floodplain approximately 3.7 km above its confluence with Hope Slough. Much of the lower 3.7 km of creek flows in exposed ditches which drain the adjacent farmland. Gravel deposits are restricted to a short section of the east and west branch located at the change in gradient near the base of the mountain.

OBSTRUCTIONS

Chilliwack Municipality maintains a passable shale trap at km 3.7 on the west branch. The accumulated shale is periodically removed by power shovel.

WATERSHED UTILIZATION

The Dunville Creek watershed is primarily an agricultural area and much of the lower 3.7 km has been channelized and denuded of protective vegetation. The licenced withdrawal of 0.7 million gallons of water per day by the Elk Creek Water Board causes severely reduced summer flows.

FISHERIES RESOURCE

Dunville Creek coho spawn in both branches at the base of the mountain. Coho spawn in the west branch from km 3.7 to 4.3, and in the east branch from km 4.0 to 4.6. Gravel exists below these sections but is poorly utilized due to the straight, unprotected nature of the channel.

Rearing potential in this sytem is poor due to intermittent summer flows in the upper sections, and to the poorly protected slough-like nature of the lower section.

ENHANCEMENT OPPORTUNITIES

Rehabilitation of the channelized portions of the spawning area may improve production from this system. However, since Hope Slough is apparently the primary nursery area for this stock, increased production is contingent upon the rearing capacity of that area.

Typical of the very limited spawning habitat which exists at the transition between flood plain and mountain.

Dunville Creek flows in open ditches through farmland for most of the lower 3.7 km.

Table 1. Mean salmon escapements to Dunville Creek, 1962 to 1978.

Year	Coho
1962-1966	150
1967-1971	355
1972-1976	91
1977[1]	450 (150)
1978[1]	300 (75)

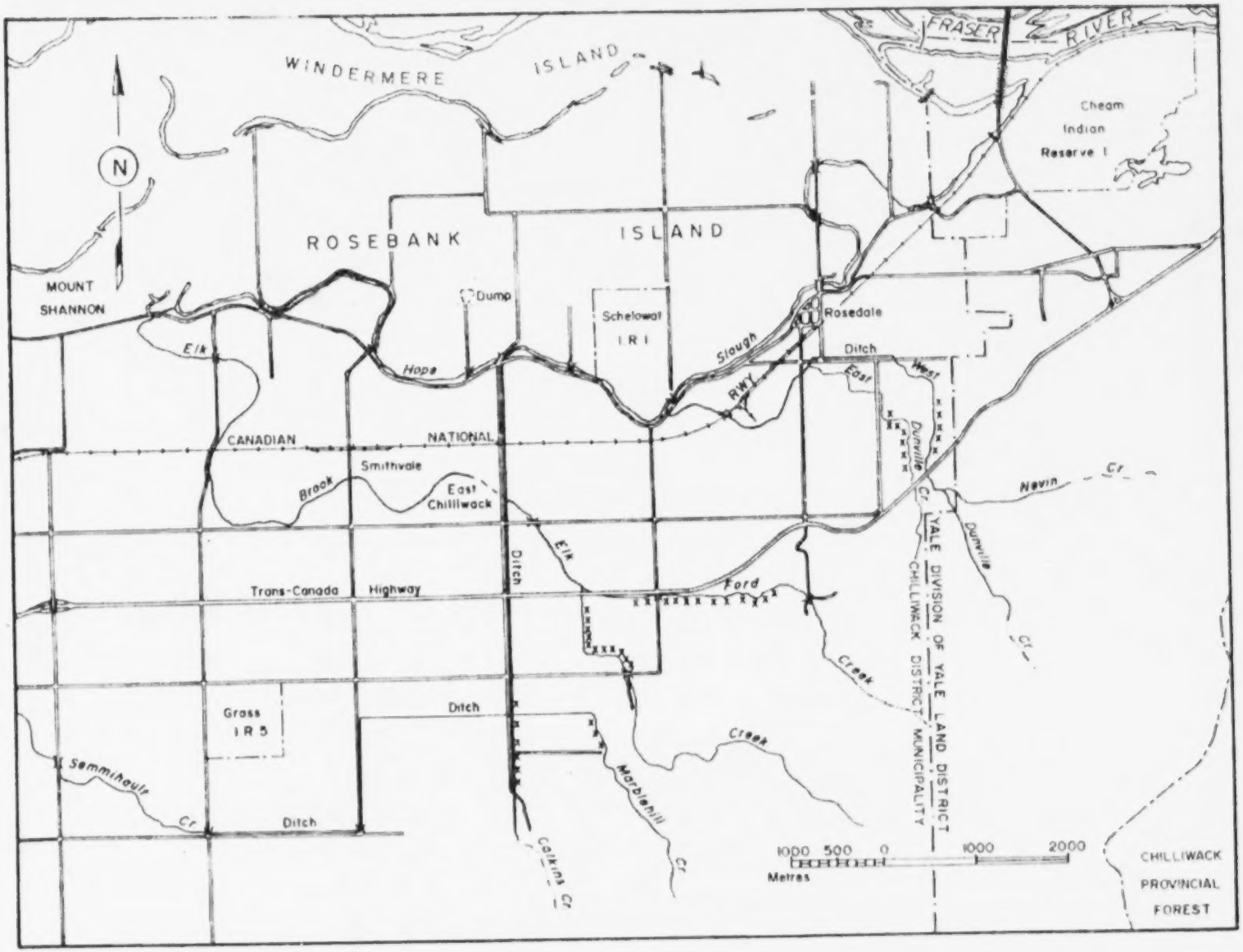
1. Bracketed figures are from the fishery officer estimates.

Table 2. Timing of coho spawning in Dunville Creek, 1970 to 1978.

Year	Spawning		
	Start	Peak	End
1970-1976	Early December	Mid December	Late January
1977	Mid November	Early February	Early March
1978	Late January	Mid February	Mid March

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Dunville Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length(mm)	N	%	Mean Length(mm)	N	%
4_3	Combined	-	0	-	--	0	-
3_2	Male	500	22	46.8	440	6	20.7
	Female	499	25	53.2	463	23	79.3
2_2	Male	-	0	-	-	0	-
Combined	Male	499	29	50.0	440	6	19.4
	Female	496	29	50.0	467	25	80.6


WINDERMERE ISLAND
FRASER RIVER
Cheam Indian Reserve 1
ROSEBANK ISLAND
N
MOUNT SHANNON
Dump
Schelowat I R 1
Rosedale
Slough
Ditch
RWY
East
West
Elk
Hope
CANADIAN NATIONAL
Smithvale
Brook
East Chilliwack
Dunville Cr
Nevin Cr
YALE DIVISION OF YALE LAND DISTRICT
CHILLIWACK DISTRICT MUNICIPALITY
Ditch
Elk
Trans-Canada Highway
Ford
Creek
Grass I R 5
Ditch
Sumas Cr
Ditch
Creek
Marblehill Cr
Colkins Cr
1000 500 0 1000 2000
Metres
CHILLIWACK PROVINCIAL FOREST

ELK CREEK

LOCATION

Flows north for approximately 10 km entering Hope Slough east of Chilliwack.

STREAM TYPE

Elk Creek is a small stream (25 km^2 watershed) with a stream type similar to Dunville Creek. The creek flows in a drainage ditch through farm fields for the lower 4.1 km, with gravel/shale deposits confined to the upper 1 km of this section. Above km 4.1, the gradient increases rapidly and the creek flows in a natural streambed from the mountain source.

Ford and 'Big Ditch' are creeks tributary to Elk Creek. Ford Creek joins Elk Creek immediately above the highway #1 crossing and is passable for approximately 2 km. The 'Big Ditch', which accepts the flow of Marblehill and Calkins Creeks, joins Elk approximately 0.6 km upstream. Both creeks have gravel deposits near the base of the mountain. Part of Calkins Creek flows in a ditch into the Semmihault Creek system.

OBSTRUCTIONS

At km 4.1 on Elk Creek there is a shale fence which consists of two-one meter high spillways. Although passable at certain discharges, there is little suitable coho spawning habitat upstream from this point.

WATERSHED UTILIZATION

The Elk Creek watershed is primarily an agricultural area. A fertilizer plant located approximately 2.5 km upstream was the only other industry noted in the system. The Elk Creek Water Board is licenced to withdraw 3.0 million gallons per day for the Chilliwack District domestic water supply. This contributes to the low summer, and occasionally, low spawning period flows observed in this system.

FISHERIES RESOURCE

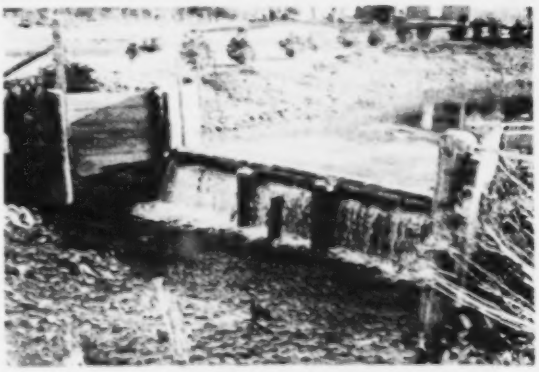
Coho spawn between kms 2.8 and 4.1 in a section of the mainstem well protected by overhanging blackberries. In Ford Creek, coho spawn in the lower 2 km, and in Marblehill and Calkins Creeks they spawn near the base of the mountain.

The rearing potential of this system is poor. The lower 3.0 km is an unprotected ditch, and the upper area is subject to summer drought (an average of 15 dry days/month for the August-October period; See Table 4).

ENHANCEMENT OPPORTUNITIES

The coho spawning and rearing habitat in Elk Creek has been severely degraded by a combination of channelization, water withdrawal, periodic siltation resulting from the shale removal operations, and the removal of much of the streamside vegetation. In view of the current state of the instream rearing habitat, it is probable that Hope Slough is the primary nursery area for this stock. If that area is underutilized, then the use of an incubation box may be the most suitable enhancement technique for this stock.

The main Elk Creek spawning area is a drainage ditch protected by a dense growth of trailing blackberries.



Outflow of the shale trap on Elk Creek. This structure is passable, however very little spawning habitat exists upstream.

Table 1. Mean salmon escapements to Elk Creek, 1962 to 1978.

Year	Coho
1962-1966	355
1967-1971	500
1972-1976	272
1977[1]	600 (400)
1978[1]	650 (250)

1. Bracketed figures are from the fishery officer estimates.

Table 2. Timing of coho spawning in Elk Creek, 1970 to 1978.

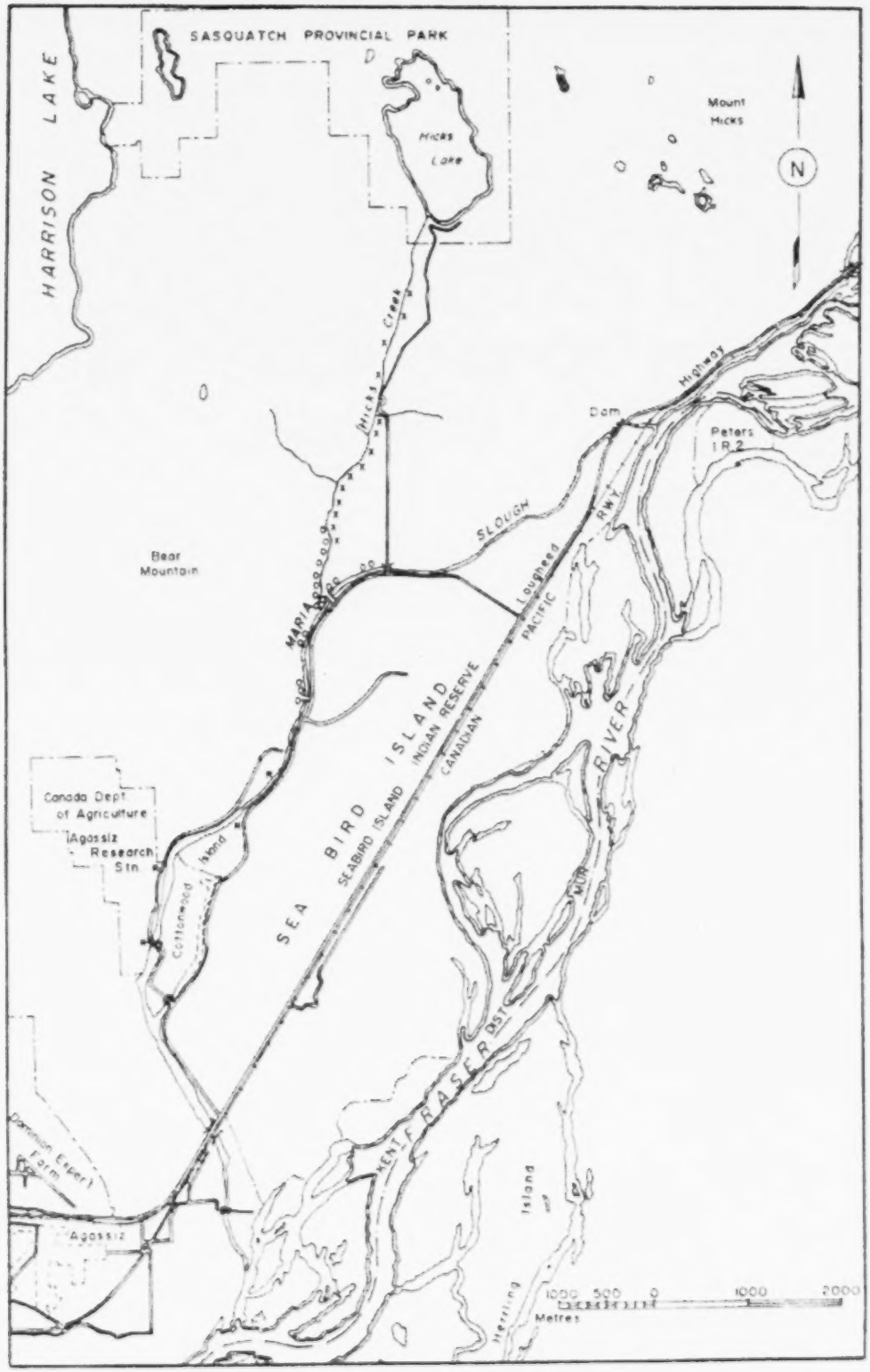
Year	Spawning		
	Start	Peak	End
1970-1976	Early December	Late December	Early February
1977	Mid November	Early February	Early March
1978	Early February	Mid February	Late March

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Elk Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length(mm)	N	%	Mean Length(mm)	N	%
4_3	Male	430	2	2.2	-	0	-
3_2	Female	504	7	7.9	-	0	-
	Male	499	34	38.2	464	19	29.7
	Female	485	36	40.5	472	42	65.6
2_2	Male	294	10	10.1	307	3	4.7
Combined	Male	454	54	49.1	439	23	31.1
	Female	486	56	50.9	472	51	68.9

Table 4. Monthly mean daily discharges in m^3/sec for Elk Creek, metered at Prairie Central Road (Station No. 08MF048).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1974	0.4	0.4	0.3	0.4	0.7	1.5	0.6	0.0	0.1	0.0	0.2	0.2	2.4(06/14)	0(08/15)
1973	-	0.1	0.1	0.1	0.6	0.3	0.1	0.0	0.1	0.1	0.1	0.4	1.4(05/18)	0(02/01)
1972	0.4	0.3	0.3	0.3	1.1	1.5	0.5	0.1	0.1	0.1	0.1	0.3	8.7(06/12)	0(08/31)


SASQUATCH PROVINCIAL PARK
HARRISON LAKE
Hicks Lake
Mount Micks
N
Hicks Creek
Dam
Highway
Peters I.R. 2
SLOUGH
Bear Mountain
MARIA SLOUGH
Loughead
PACIFIC
RWY
SEA BIRD ISLAND
SEABIRD ISLAND INDIAN RESERVE
CANADIAN
RIVER
Canada Dept of Agriculture
Agassiz Research Stn
Cottonwood Island
MOUTH
FRASER DIST
Dominion Experimental Farm
Agassiz
Herrling Island
1000 500 0 1000 2000
Metres

HICKS CREEK

LOCATION

Flows southwest from Hicks Lake for approximately 4.7 km entering Maria Slough northeast of Agassiz.

STREAM TYPE

Hicks Creek originates as seepage flow from Hicks Lake and drains a watershed of 42 km^2. In the lower 1.5 km the creek flows in a meandering, exposed channel and is generally slow moving with scattered riffles and deep pools. There are excellent gravel deposits over the next kilometer, however between kms 2.5 and 3.0 the gradient increases and the substrate is largely rubble. In the last 1.7 km the slope decreases and the creek is swampy with numerous beaver dams.

OBSTRUCTIONS

None were observed during 1977 and 1978.

WATERSHED UTILIZATION

The Hatchery and Hicks Creek outflows on Hicks Lake were dammed early in the century for hydro-electric generation by the Harrison Hotel. Only seepage flow enters Hicks Creek resulting in substantially reduced summer flows. The Hicks Lake and lower Hicks Creek areas were logged in 1961 by Eilertson Logging Ltd. Much of the streamside vegetation has been removed from Hicks Creek, both by agricultural interests and by B.C. Hydro and Dillingham Corp. in right-of-way clearance for two high tension line crossings and a natural gas pipeline crossing respectively.

FISHERIES RESOURCE

Hicks Creek chum salmon spawn in the lower 1.5 km. Coho salmon spawn throughout the creek, especially between kms 1.5 and 2.5 where two ground-water extrusions enter the creek.

Rearing potential is moderate to good, with cutbanks and pools throughout, however it may be limited by low summer flows.

ENHANCEMENT OPPORTUNITIES

Flow control from Hicks Lake should be investigated as a means of augmenting the presently low summer flows in this system.

Available coho spawning habitat can be expanded by rehabilitating the two groundwater tributaries through bank stabilization, debris removal, and gravel introduction.

Beaver dams in the upper reaches of Hicks Creek provide excellent, and possibly under utilized rearing habitat.

Habitat alteration resulting from farm and power-line right-of-way clearance.

Table 1. Mean salmon escapements to Hicks Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	1,580	30
1967-1971	1,200	35
1972-1976	695	25
1977	600	250
1978[1]	950 (75)	25

1. Bracketed figure is the fishery officer escapement estimate.

Table 2. Timing of salmon spawning in Hicks Creek, 1970 to 1978.

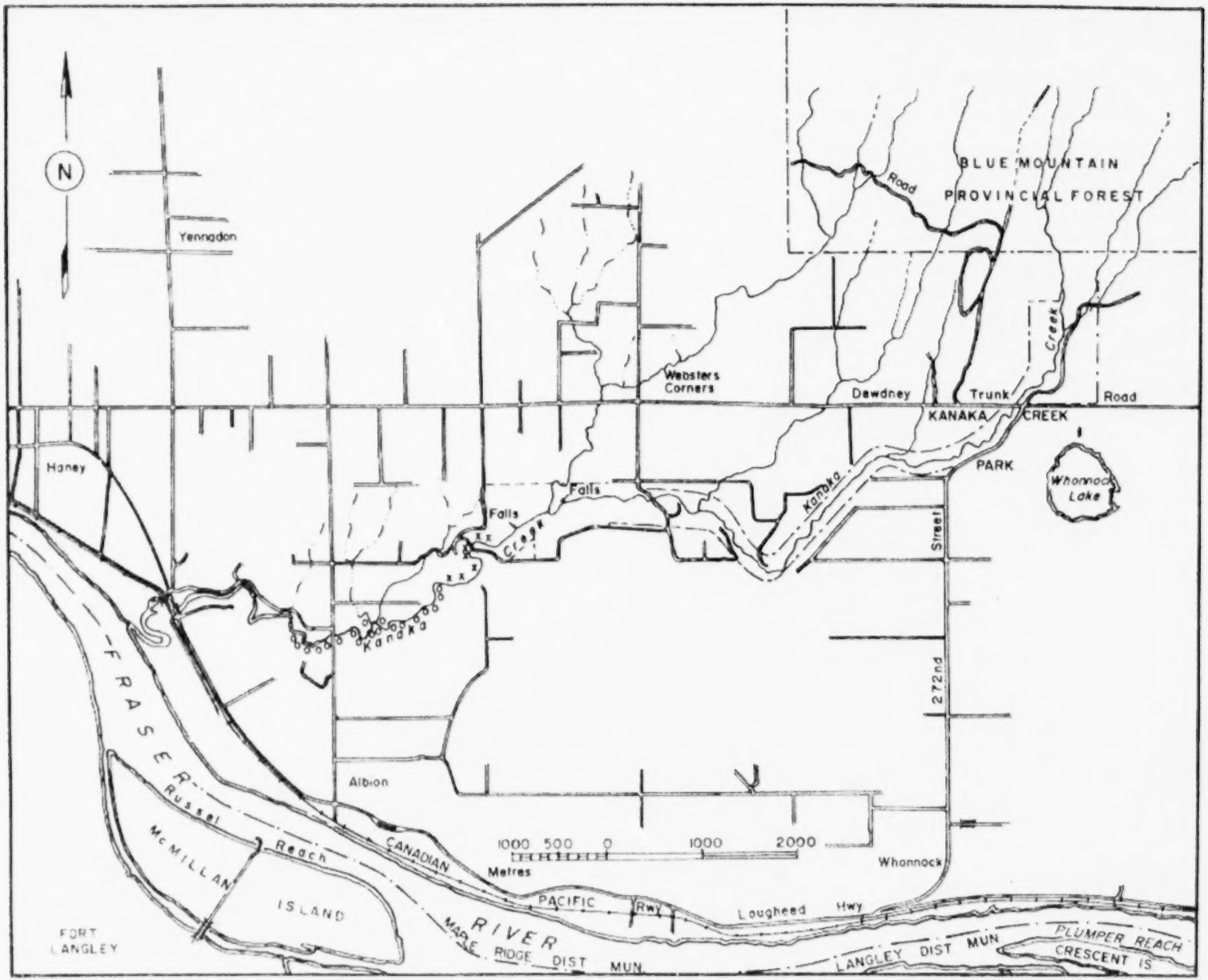
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	November	December/January	January/February
	1977	Early November	Mid February	Early March
	1978	Early November	Mid February	Early March
Chum	1970-1976	October/November	November	December
	1977	Early November	Late November	Late December
	1978	Late November	Late November	Early December

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Hicks Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length(mm)	N	%	Mean Length(mm)	N	%
4_3	Male	500	1	0.9	464	3	2.2
	Female	461	4	3.5	513	3	2.2
3_2	Male	489	53	46.1	485	49	36.0
	Female	499	52	45.2	484	78	57.4
2_2	Male	308	5	4.35	290	3	2.2
Combined	Male	474	64	48.9	476	62	40.0
	Female	496	67	51.1	484	93	60.0

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Hicks Creek chum salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
5	Male	683	2	8.7	--	0	--
	Female	-	0	-	579	1	7.7
4	Male	642	6	26.1	614	1	7.7
	Female	604	10	43.5	580	10	76.9
3	Male	600	4	17.4	560	1	7.7
	Female	570	1	4.3	--	0	--
Combined	Male	635	12	52.2	605	3	21.4
	Female	601	11	47.8	580	11	78.6


N
Yennadon
BLUE MOUNTAIN
PROVINCIAL FOREST
Road
Websters
Corners
Dewdney
Trunk
Road
KANAKA
CREEK
PARK
Whonnock
Lake
Haney
Falls
Falls
Creek
Kanaka
Kanaka
Creek
Street
272nd
FRASER
RIVER
Albion
Russel
Reach
McMILLAN
ISLAND
CANADIAN
PACIFIC
Rwy
1000 500 0 1000 2000
Metres
Whonnock
Lougheed Hwy
FORT
LANGLEY
MAPLE RIDGE DIST MUN
LANGLEY DIST MUN
PLUMPER REACH
CRESCENT IS

KANAKA CREEK

LOCATION

Flows in a southerly direction for approximately 19 km entering Fraser River northwest of McMillian Island.

STREAM TYPE

Kanaka Creek is an extensive system with a drainage of 62 km^2. The numerous upper tributaries flow across a moderately sloping plateau and form two main branches which join at 7.6 km, immediately above the canyon. The creek emerges from the canyon at 5.7 km and flows in a meandering channel across a low-lying plain, becoming slough-like in the lower 3.3 km. Excellent gravel deposits exist above 3.3 km changing to a cobble/boulder substrate for most of the canyon. Above the canyon, the north branch flows through a wide valley and has good gravel deposits throughout. The south branch has a generally higher gradient as it flows through a narrow valley from the mountain source. Except for a 400 m section of gravel near 8.2 km, the substrate is predominantly rubble/boulder.

OBSTRUCTIONS

There are two impassable rockfalls in the canyon section of Kanaka Creek: a 3 m high rockfalls 6.8 km upstream and a 6 m high rockfalls on both main branches approximately 7.6 km upstream.

WATERSHED UTILIZATION

A portion of the west branch was logged in 1945 by Matheson Bros. Logging Co. Active farming has removed much of the riparian vegetation in the lower 5.7 km causing limited bank destabilization. Seven water licences for irrigation have been issued since 1958. Commercial activities include a gravel washing operation, and log booming at the Fraser River confluence. There is scattered single residence housing, with plans for subdivision development at Webster Corners. The GVRD has purchased land in this watershed and is currently considering plans for a regional park.

Cutthroat trout were introduced by the B.C. Game Department, but are not considered to have influenced present populations (Hartman, 1968).

FISHERIES RESOURCE

Kanaka Creek chum spawn between kms 3.5 to 5.5. Coho spawn from 3.5 km upstream to the first falls, however spawning is heaviest in the lower 100 m of the canyon.

Rearing potential is generally poor.

ENHANCEMENT OPPORTUNITIES

The two rockfalls on Kanaka Creek prevent coho salmon access to almost 10 km of otherwise productive rearing habitat in the north branch. The stocking of coho fry into this area should be investigated as a technique to augment production from this stock.

The west branch of Kanaka Creek may be suitable for the stocking of coho fry.

The smaller of the two sets of falls on Kanaka Creek.

Table 1. Mean salmon escapements to the Kanaka Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	80	165
1967-1971	185	185
1972-1976	320	1400
1977[1]	50 (150)	1000 (1500)
1978[1]	100 (30)	300 (150)

1. Bracked figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Kanaka Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Late November	Late December
	1977	Early November	Early December	Early January
	1978	Early November	-	Mid March
Chum	1970-1976	Early October	Late October	Late November
	1977	Early October	Mid October	Mid November
	1978	Mid October	Late October	Mid December

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Kanaka Creek coho salmon.

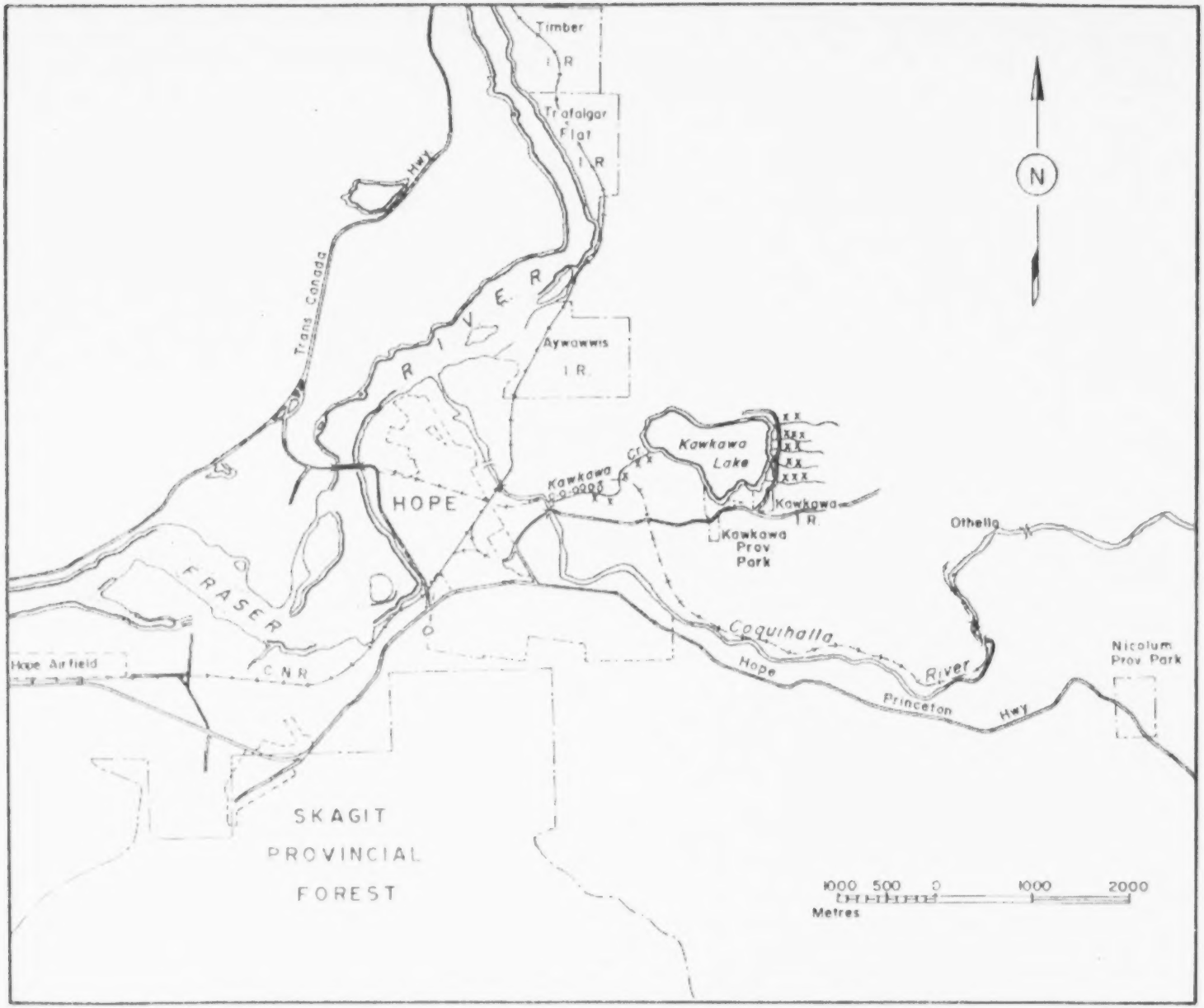
Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Combined	-	0	-	--	0	--
3_2	Male	472	5	83.3	507	1	20.0
	Female	500	1	16.7	512	2	40.0
2_2	Male	-	0	-	287	2	40.0
Combined	Male	472	5	83.3	344	4	57.1
	Female	500	1	16.7	485	3	42.9

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Kanaka Creek chum Salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
5	Male	-	0	-	606	8	12.3
	Female	-	0	-	592	3	4.6
4	Male	583	12	26.7	581	17	26.2
	Female	570	31	68.9	565	28	43.1
3	Male	547	1	2.2	543	3	4.6
	Female	525	1	2.2	539	6	9.2
Combined	Male	580	13	28.9	587	30	44.8
	Female	569	32	71.1	563	37	55.2

Table 4. Monthly mean daily discharges in m^3/sec for Kanaka Creek, metered metered at 112th Avenue (Station No. 08MH076).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	6.0	3.3	3.1	3.9	3.0	2.2	1.0	0.4	1.7	1.4	2.4	4.4	26.6(01/15)	0.2(08/05)
1975	4.4	2.9	2.9	1.5	2.3	1.2	0.2	1.0	0.3	5.5	6.8	11.4	71.4(12/02	0.1(08/06)
1974	6.7	5.9	5.3	3.9	4.1	2.0	1.3	0.2	0.3	0.3	3.6	5.7	46.7(02/03	0.2(09/24
1973	3.3	2.4	2.5	1.3	1.1	1.2	0.3	0.2	0.4	2.5	4.8	6.5	34.0(11/28	0.2(08/14)
1972	4.9	7.2	8.5	4.1	3.0	1.3	3.6	0.2	1.3	0.4	2.8	9.3	57.8(07/12)	0.2(09/14)


Timber
I R
Trafalgar
Flat
I R
Hwy
Trans Canada
F R A S E R
R I V E R
Ayawawwis
I.R.
HOPE
Kawkawa
Lake
Kawkawa
Kawkawa
I R
Kawkawa
Prov
Park
Othello
Coquihalla
River
Hope
Princeton
Hwy
Nicolum
Prov Park
Hope Airfield
C N R
SKAGIT
PROVINCIAL
FOREST
N
1000 500 0 1000 2000
Metres

KAWKAWA CREEK

LOCATION

Flows west from Kawkawa Lake for approximately 1.3 km entering Coquihalla River near Hope.

STREAM TYPE

The Kawkawa Creek system, which includes Kawkawa Lake (0.8 km^2 surface area) and its five small tributaries, drains a watershed of approximately 9 km^2. The upper part of Kawkawa Creek is marshy and braided. The remainder of the creek has a rapids/run character with a coarse gravel substrate. Excellent gravel deposits are confined to the lower 100 m of the creek.

OBSTRUCTIONS

In 1960 the Fish and Wildlife Branch installed a fish barrier approximately 100 m upstream to restrict coarse fish movement. The barrier does not impede salmonid migrations.

There are a series of passable beaver dams on the upper creek near the lake outlet.

WATERSHED UTILIZATION

Much of the land bordering Kawkawa Lake and the upper tributaries has been developed for recreational use and several domestic water licences have been issued. The upper tributaries have been channelized where they pass through a small subdivision. In 1960, the Fish and Wildlife Branch built a barrier and poisoned the lake in an attempt to eradicate the coarse fish populations.

FISHERIES RESOURCE

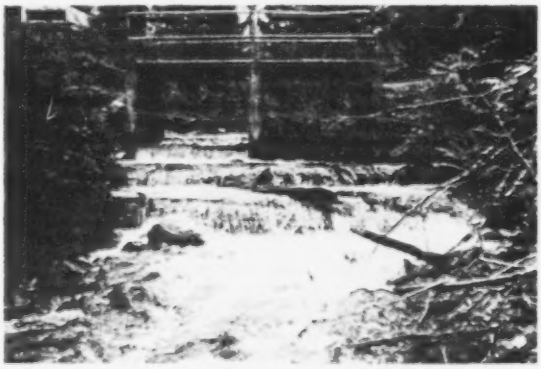
Coho spawn in the five small streams tributary to Kawkawa Lake and throughout the lower creek. Chum and pinks spawn in the lower 100 m of Kawkawa Creek.

Rearing potential appears excellent in upper Kawkawa Creek where beaver impoundments, extensive vegetation and instream debris provide cover. The coho scale pattern shows excellent freshwater growth.

ENHANCEMENT OPPORTUNITIES

Based on the estimated available rearing habitat in Kawkawa Lake, the Kawkawa Creek system appears to be underutilized by coho salmon. A possible reason is the limited nature and poor quality of the spawning habitat in the upper tributaries, however further studies are needed to determine the precise production limiting factor.

Typical coho spawning habitat in one of the five small streams tributary to Kawkawa Lake.



Coarse fish barrier near the mouth of Kawkawa Creek.

Table 1. Mean salmon escapements to Kawkawa Creek, 1962 to 1978.

Year	Coho	Chum	Sockeye	Pinks (odd year)
1962-1966	140	25	45	200
1967-1971	644	89	102	967
1972-1976	525	204	34[1]	850
1977[2]	600	350	-	(350)
1978[2]	400 (250)	300	-	-

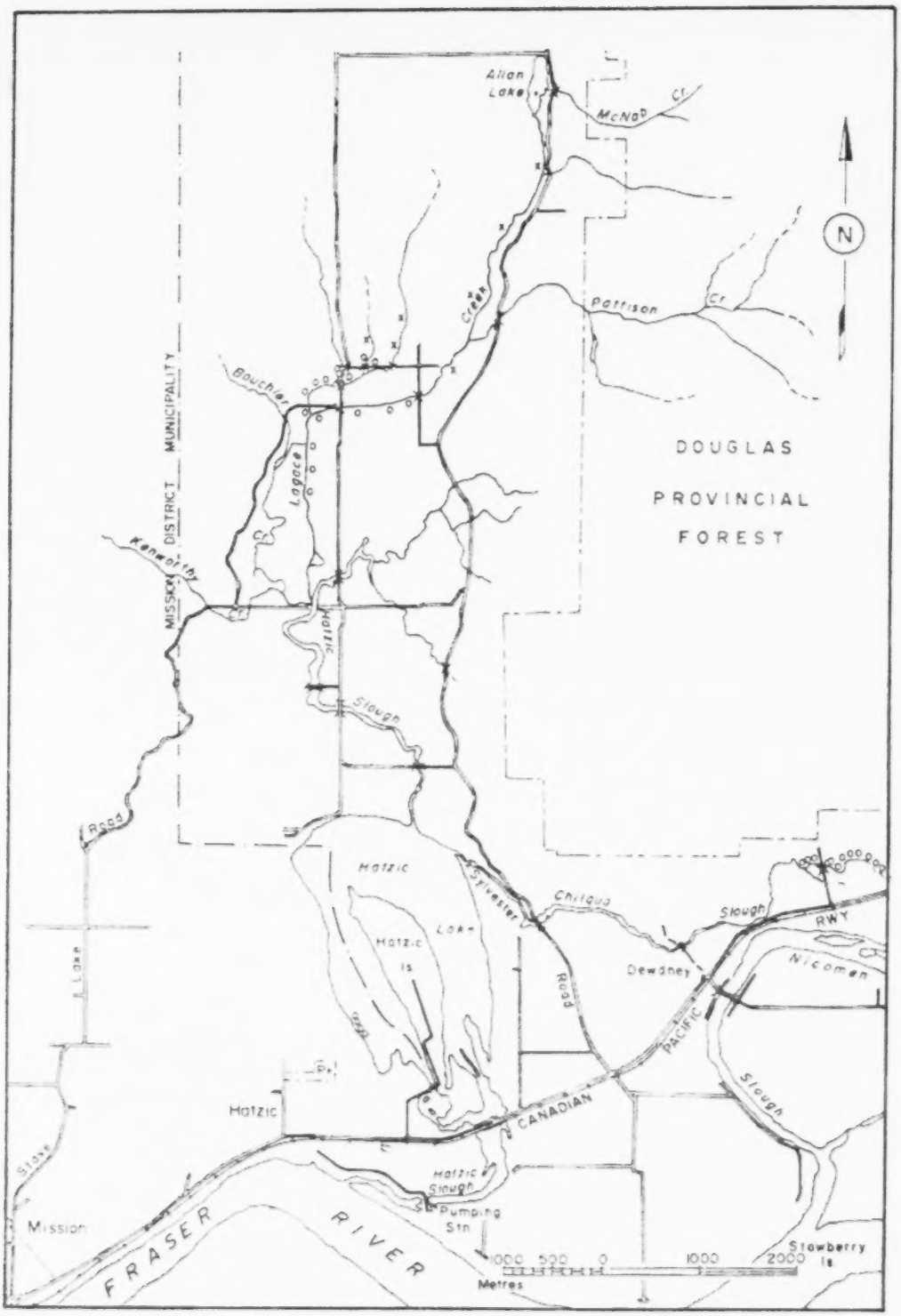
1. 3 years only. Not reported since 1974.
2. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Kawkawa Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Mid November	Late November	Late December
	1977	Mid November	Late November	Early January
	1978	Late October	Early December	Late December
Chum	1970-1976	Mid October	Late October	Early November
	1977	Early October	Mid October	Early December
	1978	Mid September	Mid October	Early November
Pink	1970-1976	Early October	Mid October	Early November

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Kawkawa Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean length ((mm)	N	%
4_3	Male	-	0	-	463	2	2.7
	Female	613	2	7.7	--	0	--
3_3	Male	405	2	7.7	347	4	5.4
	Female	410	1	3.8	--	0	--
3_2	Male	432	5	19.2	480	20	27.8
	Female	537	11	42.3	526	43	59.7
2_2	Male	286	5	19.2	307	5	6.9
Combined	Male	359	14	50.0	434	31	40.8
	Female	539	14	50.0	524	45	59.2


Allan Lake
McNab Cr
N
Creek
Pattison Cr
Boucher
Lagace Cr
DOUGLAS
PROVINCIAL
FOREST
MISSION DISTRICT MUNICIPALITY
Kenworthy
Hatzic Slough
Road
Hatzic
Hatzic Lake
Hatzic Is
Dyke
Sylvester Road
Chrigua Slough
RWY
Dewdney
Nicomen Slough
PACIFIC
CANADIAN
Hatzic
Hatzic Slough
Pumping Stn
Mission
FRASER RIVER
Strawberry Is
1000 500 0 1000 2000
Metres

LAGACE (BOUCHIER) CREEK

LOCATION

Flows south for approximately 11 km entering Hatzic Slough, north of Hatzic Lake.

STREAM TYPE

Lagace Creek flows through a broad, steep-sided valley and drains a watershed of 32 km^2. The upper creek drains Allan Lake and is joined by several steep mountain tributaries before dropping through a 0.6 km long gulley onto the Hatzic Prairie. In the lower 4 km, Lagace Creek flows in a dyked channel and is slough-like in the final kilometer.

Lagace Creek is joined by several tributaries, however an unnamed stream which enters approximately 2 km upstream is the only one important to salmonids. Misidentified in escapement files as "Bouchier Creek", the lower 1.5 km of this stream has a riffle/pool character and contains the only extensive gravel deposits in the system.

OBSTRUCTIONS

None were observed during 1977 or 1978. However, all anadromous species in the system must pass through the Hatzic Pumping Station at the outflow of Hatzic Lake. The flood gates are regulated by water levels and periodically close, preventing migration of adults and juveniles.

WATERSHED UTILIZATION

Ongoing logging operations in the eastern watershed by Canadian Forest Products, especially near Patterson Creek (confluence 4.0 km upstream), have disrupted flow patterns and caused siltation and extensive scouring throughout the lower 4.0 km. This entire section has been channelized and diked and regular gravel removal occurs.

There are water licences in effect both for irrigation and for a fish culture operation.

FISHERIES RESOURCE

Chum spawning is heavy in the lower 1.2 km of the tributary, and light in the mainstem between kms 1.8 to 3.3.

Coho spawning is scattered throughout the system.

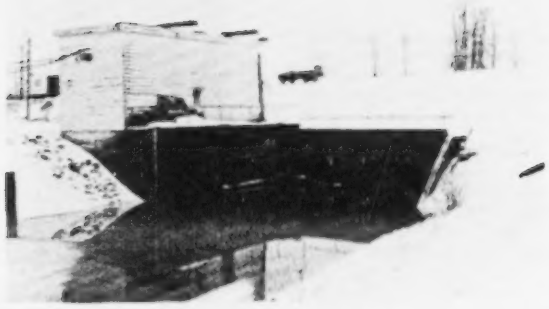
Rearing potential is good in the tributary, and between 4 kms and Allan Lake in the mainstem.

ENHANCEMENT OPPORTUNITIES

Lagace Creek can potentially support larger coho and chum stocks, however present production is limited by an unstable flow regime and by the presence of a pumphouse at the outlet of Hatzic Lake. Until these problems are resolved, enhancement activities should be confined to bank stabilization and replanting in the main spawning tributary.

The mainstem chum spawning area on Lagace Creek has been channelized for flood control.

Tributary chum spawning habitat.



The Hatzic Slough pumphouse.

Table 1. Mean salmon escapements to Logace Creek and tributary, 1962 to 1978.

	Logace Creek		Tributary (Bouchier)	
	Coho	Chum	Coho	Chum
1962-1966	0	15	25	311
1967-1971	25[1]	0	25	220
1972-1976	125[2]	108[3]	25	270
1977[4]	25 (50)	N/R (400)	25	400
1978[4]	25	100 (200)	25	300 (75)

1. Present 2 years only. 2. Present 4 years only. 3. Present 3 years only.
4. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Logace Creek system, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	October/November	November/December	January
	1977	Early November	Early December	Late December
	1978	Late October	-	Late December
Chum	1970-1976	September/October	November	December
	1977	Mid October	Early November	Late November
	1978	Early October	Late October	Late December

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Lagoce System coho salmon.

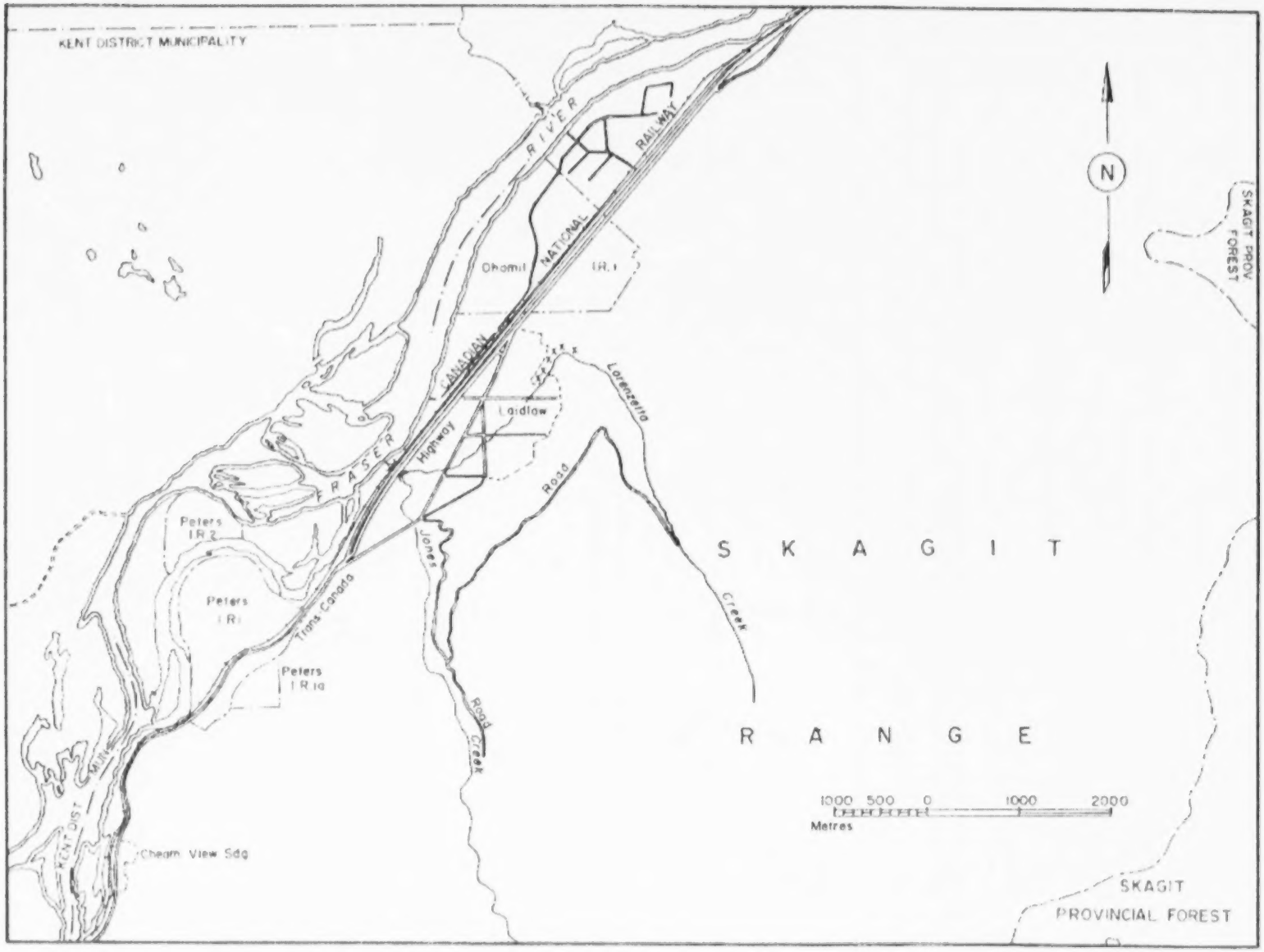
Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean length ((mm)	1978 N	1978 %
43	Combined	-	0	-	--	0	--
32	Male	425	2	66.7	--	0	--
	Female	462	1	33.3	523	2	100
22	Male	-	0	-	--	0	--
Combined	Male	425	2	66.7	557	1	25.0
	Female	462	1	33.3	513	3	75.0

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Lagoce System chum salmon.

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length (mm)	1978 N	1978 %
5	Male	-	0	-	590	2	2.3
	Female	-	0	-	612	2	2.3
4	Male	571	8	29.6	589	24	27.9
	Female	561	12	44.5	576	37	43.0
3	Male	557	3	11.1	526	7	8.1
	Female	538	4	14.8	528	14	16.3
Combined	Male	567	11	40.7	577	34	39.1
	Female	555	16	59.3	565	53	60.9

Table 4. Monthly mean daily discharges in m^3/sec for the unnamed creek entering Lagoce Creek 2 km upstream (Station No. 08MH095).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1964	2.6	0.9	1.4	1.3	-	-	-	-	-	-	-	-	-	-
1963	1.1	1.0	0.6	0.7	-	-	-	-	0.3	0.8	2.9	2.6	28.0(11/26)	0.3(10/02)
1962	1.6	0.8	0.7	0.7	-	-	-	-	0.5	1.7	1.7	2.0	14.1(11/19)	0.3(09/04)
1961	1.6	1.9	1.1	1.0	-	-	-	-	0.4	1.4	1.1	1.7	10.5(01/15)	0.3(09/12)
1960	1.0	0.9	0.8	0.9	-	-	-	-	0.5	1.1	0.8	0.8	3.9(10/22)	0.4(09/10)


KENT DISTRICT MUNICIPALITY
RIVER
RAILWAY
N
SKAGIT PROV FOREST
Ohamil
NATIONAL
I.R. 1
CANADIAN
Ladlow
Lorenzetto
Highway
FRASER
Road
Peters
I.R. 2
Peters
I.R. 1
Peters
I.R. 1a
Trans Canada
Jones
Creek
Road
Creek
S K A G I T
R A N G E
1000 500 0 1000 2000
Metres
KENT DIST
Cheam View Sdg
SKAGIT
PROVINCIAL FOREST

LORENZETTA CREEK

LOCATION

Flows in a westerly direction for approximately 8.7 km entering Jones Creek, near the Fraser River confluence, at Loidlow.

STREAM TYPE

Lorenzetta Creek is a steep gradient mountain stream which drains a watershed of approximately 11 km^2. The lower 2.3 km of the creek flows across the Fraser River flood plain and is predominantly slough-like with isolated gravel deposits. Above this area is a channelized chute which extends to the base of the mountain.

OBSTRUCTIONS

There are a series of small beaver dams in the lower 2 km, all of which are passable to migrating adults.

WATERSHED UTILIZATION

The mountain headwaters were logged between 1955 - 1959 and intermittently until 1970. In the lower 3.2 km the creek passes through farmland where some streamside vegetation has been removed. In 1976 and 1977 Environment Canada channelized a 500m section at the mountain base in order to prevent further breakouts and flooding caused by bed load deposition. This operation removed most of the spawning gravel from this section.

FISHERIES RESOURCE

Coho spawn primarily between kms 2.3 and 2.6, with little spawning in the channelized section. Chum spawning is scattered below 2.3 km, and may consist entirely of strays from Jones Creek.

Rearing potential of the system appears good below 2.5 km where beaver dams and instream debris provide cover.

ENHANCEMENT OPPORTUNITIES

Based on stream length and available rearing habitat, Lorenzetta Creek appears to be fully utilized by coho salmon.

A short section of excellent spawning habitat immediately below the channelized chute.

Most of the lower 2.3 km of Lorenzetta Creek is deep, with extensive instream debris and beaver dams.

Table 1. Mean salmon escapements to Lorenzetta Creek, 1962 to 1978.

Year	Coho	Chum	Pink (odd year)
1962-1966	190	25	25
1967-1971	292	25[1]	208
1972-1976	155	40[1]	65
1977[2]	75 (100)	(100)	20
1978[2]	150 (15)	25	-

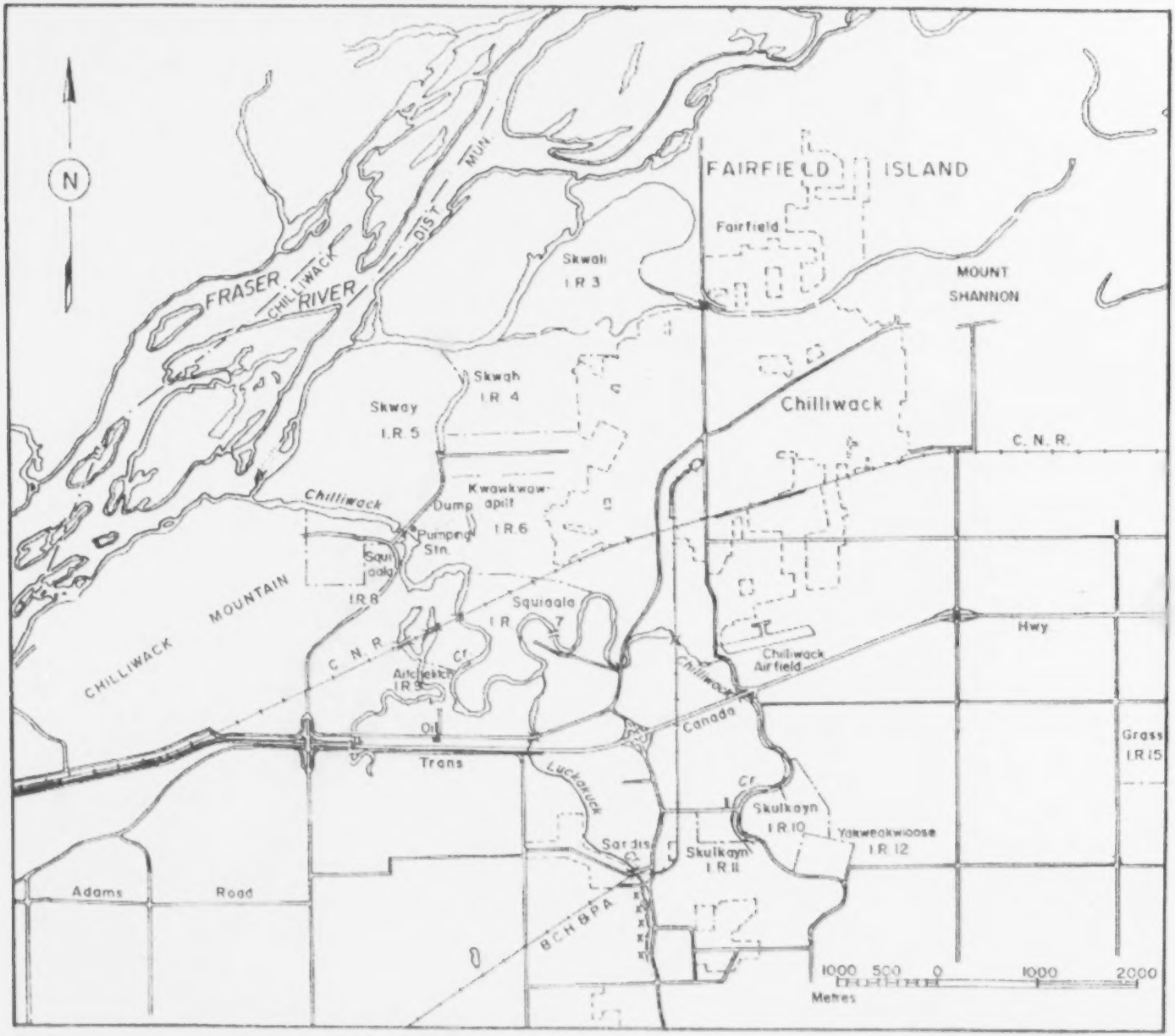
1. Sighted in 4 years only.
2. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Lorenzetta Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Late October	Mid October	Late December
	1977	Early November	Late December	Early February
	1978	Early November	Early January	Early March
Chum	1970-1976	Early October	Mid October	Late October
Pink	1970-1976	Late September	Mid October	Late October

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Lorenzetta Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean length (mm)	N	%
4_3	Male	-	0	-	--	0	--
	Female	-	0	-	492	1	3.1
3_2	Male	490	11	68.8	468	12	46.2
	Female	474	3	18.7	487	13	50.0
2_2	Male	298	2	12.5	--	0	--
Combined	Male	454	14	82.4	462	16	43.2
	Female	474	3	17.6	486	21	56.8


N
FRASER RIVER
CHILLIWACK DIST MUN
FAIRFIELD ISLAND
Fairfield
MOUNT SHANNON
Skwah I.R.3
Skwah I.R.4
Skway I.R.5
Chilliwack
C.N.R.
Kwawkwaw-apilt I.R.6
Dump
Pumping Stn.
Squiaala I.R.8
Squiaala I.R.7
CHILLIWACK MOUNTAIN
Hwy
Chilliwack Airfield
Canada
Trans
Luckakuck
Skulkayn I.R.10
Yakweakwioose I.R.12
Skulkayn I.R.11
Grass I.R.15
Adams Road
BCHBPA
1000 500 0 1000 2000
Metres

LUCKAKUCK CREEK

LOCATION

Flows north for approximately 3.5 km entering Chilliwack Creek near Chilliwack.

STREAM TYPE

Luckakuck Creek is a stable spring-fed system which drains a low lying watershed of approximately 4.8 km^2. Arising in a series of small, shallow ponds, the creek flows in a meandering channel through low-lying meadowland. The substrate is predominately silt, with gravel deposits located only near the numerous culvert outflows and in areas of upwelling in the upper 1 km. Aquatic vegetation grows throughout the channel.

OBSTRUCTIONS

All migrating fish must pass through the Chilliwack Creek Pumping Station. Flapper valves which are regulated by direction of water flow periodically close preventing fish passage.

WATERSHED UTILIZATION

The Luckakuck Creek watershed is an extensively developed urban and suburban area which includes the town of Sardis. A Dairyland plant draws water from the creek at Spruce Road, and the upper 1.8 km flow through a subdivision which has altered the stream channel and removed much of the streamside vegetation. The lower 1.7 km of the creek flows through farmland.

FISHERIES RESOURCE

Coho spawn in the exposed areas near culvert outflows in the upper 1.5 km.

Rearing potential of the system is good but may be adversely influenced by factors associated with the level of commercial and residential development of the watershed.

ENHANCEMENT OPPORTUNITIES

The excellent overwintering habitat and the large number of residences bordering the stream make Luckakuck Creek an excellent prospect for a supplemental feeding program. However, the Chilliwack Creek pumphouse problem should be resolved prior to any enhancement in this system.

The main spawning area for Luckakuck Creek coho is a series of shallow ponds located in a Sardis residential area.

Most habitat in Luckakuck Creek is deep with a silt substrate.

Table 1. Mean salmon escapements to Luckakuck Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	90	25
1967-1971	38[1]	54
1972-1976	90	23[2]
1977[3]	100 (200)	0
1978[3]	250 (200)	0

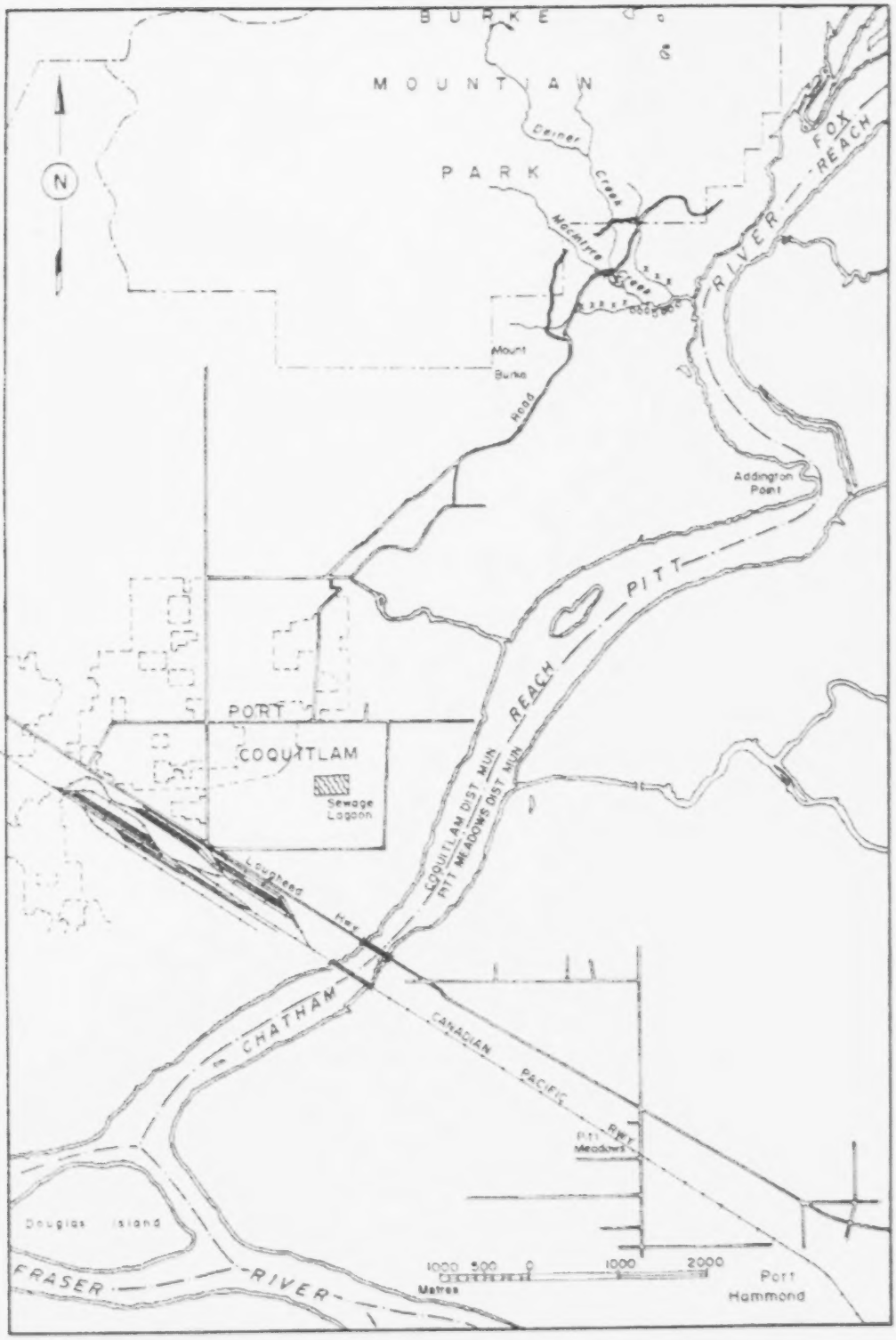
1. Sighted one year only.
2. Sighted two years only.
3. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Luckakuck Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early December	Mid December	Mid January
	1977	Mid November	Late December	Early February
	1978	Mid November	Late January	Late February
Chum	1970-1976	Mid November	Late November	Early December

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Luckakuck Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Male	-	0	-	419	2	2.8
	Female	405	1	11.1	432	2	2.8
3_2	Male	445	2	22.2	467	23	32.4
	Female	486	6	66.7	461	44	62.0
2_2	Male	-	0	-	—	0	--
Combined	Male	475	3	30.0	462	29	35.8
	Female	474	7	70.0	457	52	64.2


BURKE
MOUNTAIN
PARK
Coliner Creek
Mackenzie Creek
FOX RIVER REACH
Mount Burke Road
Addington Point
PITT RIVER REACH
PORT COQUITLAM
Sewage Lagoon
COQUITLAM DIST MUN
PITT MEADOWS DIST MUN
Lougheed Hwy
CHATHAM
CANADIAN PACIFIC RWY
Pitt Meadows
Douglas Island
FRASER RIVER
1000 500 0 1000 2000
Metres
Port Hammond
N

MACINTYRE CREEK

LOCATION

Flows in an easterly direction for approximately 3 km entering Pitt River north of Port Coquitlam.

STREAM TYPE

MacIntyre Creek arises on Burke Mountain and drains a watershed of approximately 8 km^2. Two tributaries join MacIntyre Creek at kms 0.1 and 0.5. The former is a series of beaver ponds and the latter is relatively steep throughout. The lower 0.7 km of the creek is slough-like with scattered riffles and is well protected by streamside vegetation. Gravel deposits exist from 0.4 km to 1.6 km, above which the gradient increases and the substrate is cobble and boulder.

OBSTRUCTIONS

No obstructions were observed during 1977 or 1978.

WATERSHED UTILIZATION

The central part of the watershed was logged in the early 1900's and is currently in stable second growth. The upper and lower reaches were logged from 1967 - 1972 by Anderson Bros. Ltd. The B.C. Housing Corporation is currently considering plans for a residential development on the west and south-east sides of Burke Mountain.

FISHERIES RESOURCE

Coho spawn between kms 0.4 and 1.6, and chum spawn in the lower 1 km.

Rearing potential is fair in the lower 0.8 km where streamside vegetation, cut banks, and isolated pools provide cover.

ENHANCEMENT OPPORTUNITIES

Based on an assessment of stream length and available rearing habitat, MacIntyre Creek appears to be fully utilized by coho salmon. The stream can support a larger chum stock than has been evident in recent years, however chum escapements appear to be determined largely by harvesting rates.

Excellent coho spawning and rearing habitat in the middle reaches of MacIntyre Creek.

MacIntyre Creek near the confluence with the Pitt River.

Table 1. Mean salmon escapements to MacIntyre Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	70	155
1967-1971	95	135
1972-1976	60	115
1977[1]	400 (35)	1000 (25)
1978[1]	375 (25)	25 (50)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in MacIntyre Creek, 1970 to 1978.

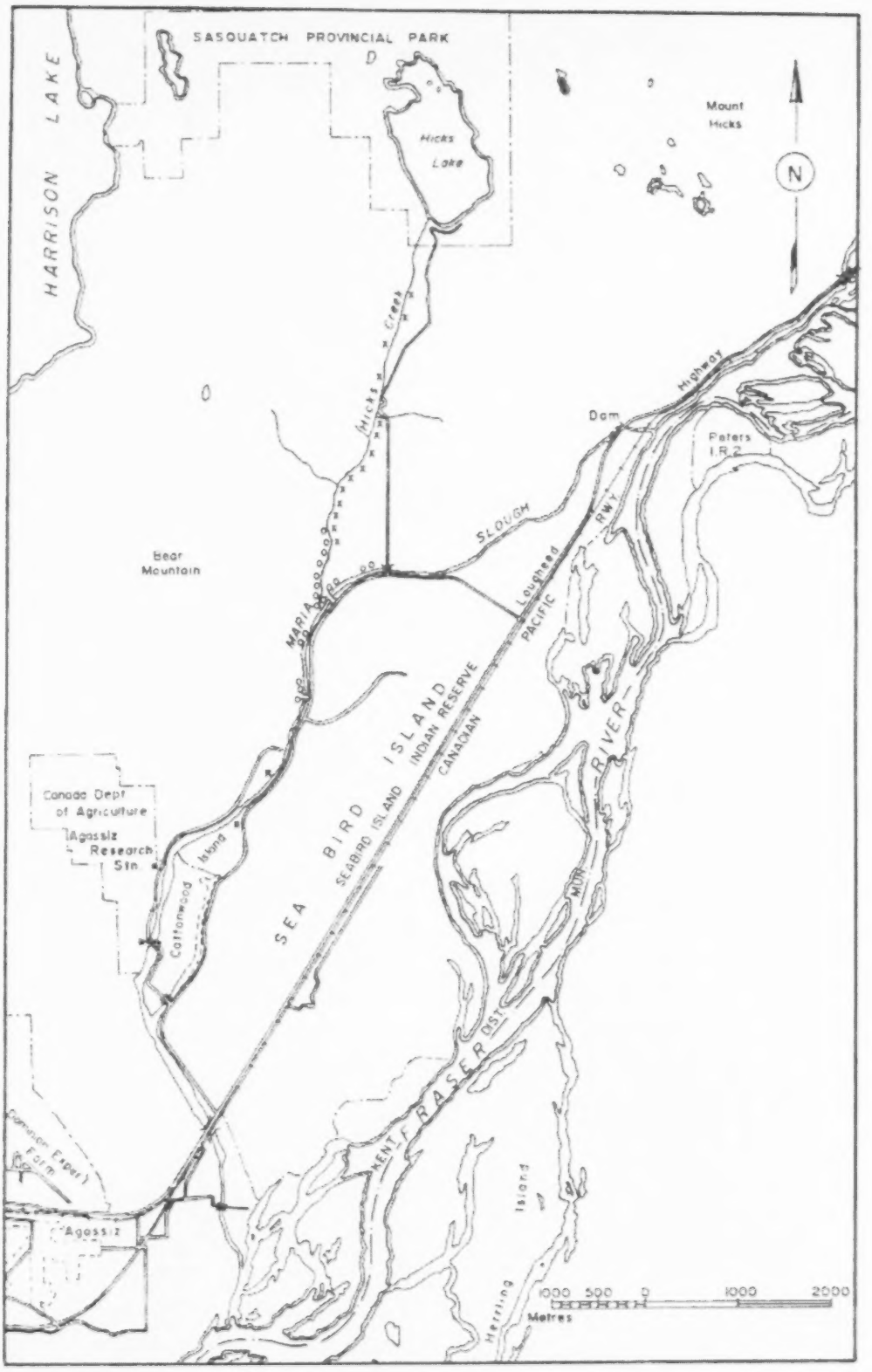
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Mid November	Early December	Late December
	1977	Late October	Late November	Early February
	1978	Late October	Mid November	Early February
Chum	1970-1976	Mid October	Early November	Mid November
	1977	Mid October	Early November	Early December
	1978	Late October	Late October	Late November

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 MacIntyre Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
4_3	Male	-	0	-	359	1	3.4
	Female	-	0	-	508	2	6.9
3_2	Male	507	3	30.0	385	8	27.6
	Female	494	5	50.0	496	16	55.2
2_2	Male	283	2	20.0	225	2	6.9
Combined	Male	409	10	58.8	356	14	38.9
	Female	497	7	41.2	490	22	61.1

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 MacIntyre Creek chum salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
5	Male	620	1	1.0	--	0	--
	Female	600	3	2.9	--	0	--
4	Male	601	37	35.6	--	0	--
	Female	571	60	57.7	552	1	33.3
3	Male	540	1	1.0	--	0	--
	Female	530	2	1.9	518	2	66.7
Combined	Male	600	39	37.5	--	0	--
	Female	572	65	62.5	529	3	100


SASQUATCH PROVINCIAL PARK
HARRISON LAKE
Hicks Lake
Mount Hicks
N
Hicks Creek
Dam
Highway
Peters I.R.2
SLOUGH
RWY
Bear Mountain
MARIA SLOUGH
Loughead
PACIFIC
SEA BIRD ISLAND
SEABIRD ISLAND INDIAN RESERVE
CANADIAN
RIVER
Canada Dept of Agriculture
Agassiz Research Stn
Cottonwood Island
MOUTH
FRASER DIST
Dominion Experl Farm
Agassiz
Herrling Island
1000 500 0 1000 2000
Metres

MARIA SLOUGH

LOCATION

Maria Slough flows south for approximately 13 km entering Fraser River east of Agassiz.

STREAM TYPE

Maria Slough is a former Fraser River side channel which drains a watershed estimated at 7 km^2. It flows through low-lying farmland bordered by the Kent District mountains to the northwest. Maria Slough is subject to heavy aquatic plant growth which is slowly reclaiming the available spawning area. Gravel deposits exist only at constricted, fast flowing areas, particularly on either side of culvert crossings.

Hicks Creek, the main tributary of Maria Slough, is described elsewhere in this report.

OBSTRUCTIONS

The CPR crossing at the upper end of Maria Slough blocks all but seepage flow from the Fraser River.

WATERSHED UTILIZATION

Early developments included the establishment of an Indian reserve on Sea Bird Island in 1879, and the logging of the Kent District mountains early in the century. The Agassiz Correctional Work Camp discharged effluent into the slough until 1975 when a secondary sewage treatment plant was installed. Farm clearance, and the construction of two power lines in 1972 and 1976 has resulted in the removal of much of the streamside vegetation.

FISHERIES RESOURCE

Chum spawn in the available gravel deposits throughout the slough: below the Cottonwood Is. bridge crossings 2.2 km and 2.8 km upstream; in a short section 300 m above the Hicks Creek confluence.

Chinook spawn below the second Cottonwood Is. bridge at 2.8 km, in two sections beside the Agassiz Corrections camp at 3.3 km an 3.7 km, and at a constriction 5.7 km upstream.

Coho have been reported throughout the slough, and were observed spawning above the Hicks Creek confluence.

Pinks have not been reported since 1971.

Rearing potential is questionable due to heavy siltation and aquatic plant growth and to observed fecal contamination from the adjacent farmland.

ENHANCEMENT OPPORTUNITIES

The feasibility of manipulating flows in conjunction with mechanical silt removal should be assessed as a means of improving chum and pink salmon production.

Table 1. Mean salmon escapements to Maria Slough, 1962 to 1978.

Year	Coho	Chum	Chinook	Pink (odd year)	Sockeye
1962-1966	240	430	137	--	25
1967-1971	215	775	190	400	150
1972-1976	175	350	115	—	90
1977[1]	-(200)	300 (400)	(200)	—	(200)
1978[1]	-(200)	300 (200)	150 (200)	--	(75)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Maria Slough, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	October	November/December	January
Chum	1970-1976	October	November	December/January
	1977	Early November	Late November	Late December
	1978	Early November	Late November	Late December
Chinook	1970-1976	September	September/October	November
	1978	Late September	Early October	Late October
Sockeye	1970-1976	September	October	November

Table 3(a). Age, mean posterbital-hypural plate length, and sex composition of 1977 and 1978 Maria Slough chum salmon.

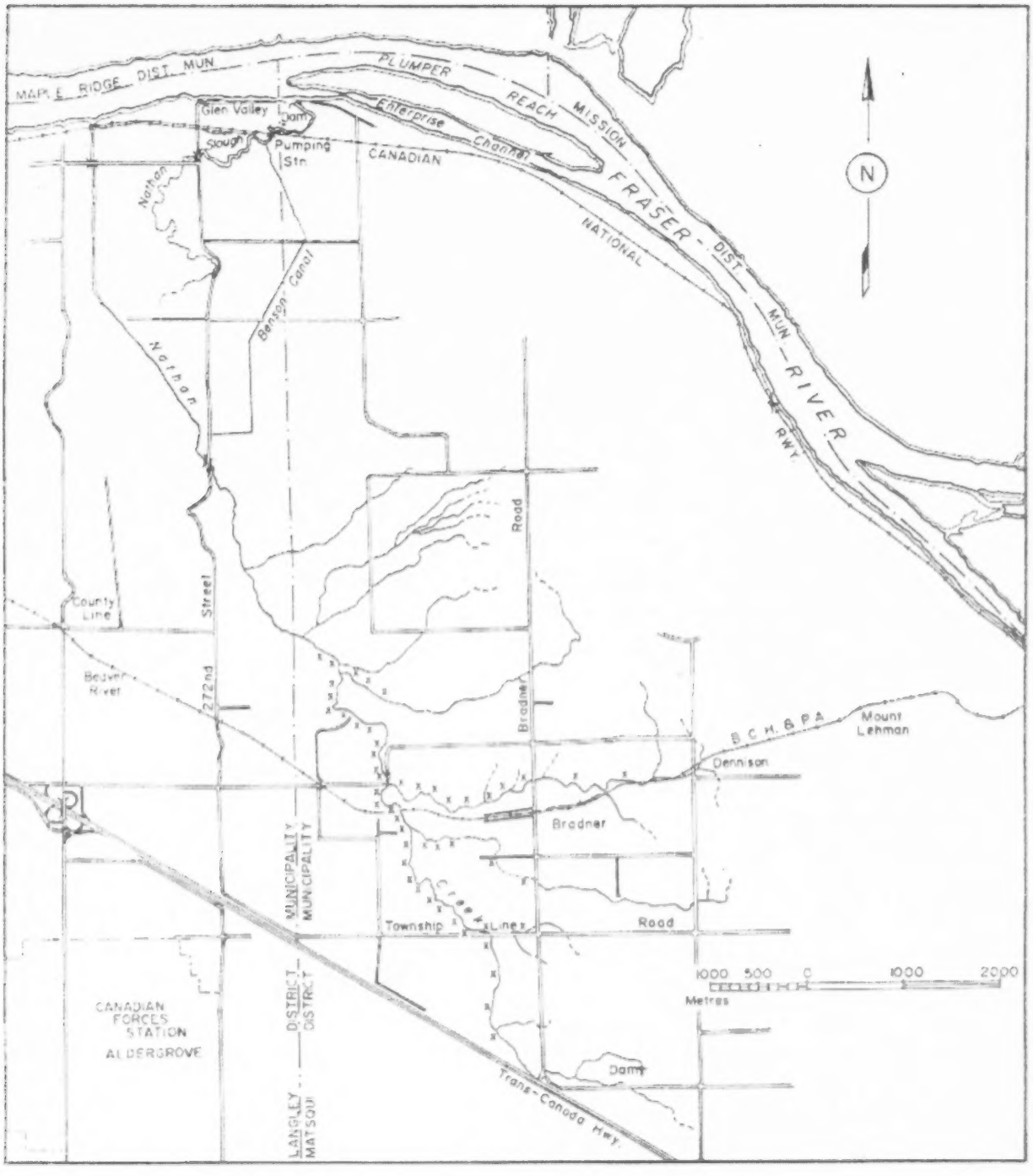
Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
5	Male	-	0	-	--	0	--
	Female	-	0	-	--	0	--
4	Male	630	3	33.3	606	7	31.8
	Female	613	2	22.2	576	11	50.0
3	Male	610	1	11.1	583	3	13.6
	Female	570	3	33.3	570	1	4.5
Combined	Male	632	5	50.0	599	10	43.5
	Female	587	5	50.0	570	13	56.5

Table 3(b). Age, mean posterbital-hypural plate length, and sex composition of 1978 Maria Slough chinook salmon.

Age	Sex	1978 Mean Length (mm)	1978 N	1978 %
2_1	Male	360	2	18.2
4_1	Male	685	1	9.1
	Female	674	8	72.7
Combined	Male	468	3	25.0
	Female	674	9	75.0

Table 4. Monthly mean daily discharges in m^3/sec for Maria Slough, metered at Ruby Creek bridge (Station No. [illegible]).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1963	3.5	2.6	1.7	-	-	-	-	-	-	-	-	-	-	-
1962	3.3	2.4	1.2	-	-	-	-	-	-	-	-	4.6	-	-
1961	4.8	4.0	2.4	-	-	-	-	-	-	-	-	2.3	-	-
1960	1.9	2.7	1.7	-	-	-	-	-	-	-	-	2.3	-	-


MAPLE RIDGE DIST MUN
PLUMPER REACH
MISSION
Glen Valley
Dam
slough
Pumping Stn
CANADIAN
Enterprise Channel
FRASER - DIST
NATIONAL
MUN - RIVER
RWY
N
Norton
Benson Canal
Kanaka
Road
County Line
Street
Beaver River
272nd
Bradner
B C H & P A
Mount Lehman
Dennison
Bradner
MUNICIPALITY
MUNICIPALITY
Township
Line
Road
1000 500 0 1000 2000
Metres
CANADIAN FORCES STATION ALDERGROVE
DISTRICT
DISTRICT
LANGLEY
MATSQUI
Dam
Trans-Canada Hwy.

NATHAN (BEAVER) CREEK

LOCATION

Flows north for approximately 15 km entering Fraser River 2 km west of Crescent Island.

STREAM TYPE

Nathan Creek and tributaries drain a watershed area of 34 km^2. It arises on a gently sloping plateau and is well protected throughout the upper section by instream debris and a dense second growth forest. A progressive narrowing and deepening of the stream valley occurs and by 6.9 km the stream type is rapids/riffle as it flows through a deep gulley. At 3.5 km the gulley ends and the creek flows across farmland in a channelized and dyked stream bed. The lower 1.8 km is slough-like.

OBSTRUCTIONS

No obstructions were observed during 1977 and 1978.

WATERSHED UTILIZATION

Much of the creek flows through undisturbed deciduous forest, although single residences border the creek in the headwaters and subdivision construction is proceeding at the 60th Avenue crossing. Subdivisions also line the east side of the gulley. The lower 3.5 km of Nathan Creek flows through farmland, where the creek has been channelized and dyked since 1909.

FISHERIES RESOURCE

Nathan Creek coho spawn throughout the mainstem between kms 7 and 11; in the lower 2 km of a tributary which joins Nathan Creek at Interprovincial Road (8.6 km upstream); and in the lower 200 m of a tributary which joins the mainstem at 9.4 km.

Rearing potential is good, with extensive instream debris and well protected pools.

ENHANCEMENT OPPORTUNITIES

Local residents have expressed an interest in salvaging juveniles stranded in the upper reaches by low flows each summer. Otherwise, Nathan Creek is a productive coho stream which flows primarily within a ravine and is generally undistrubed by streamside development.

The feasibility of reestablishing a chum stock in lower Nathan Creek should be investigated.

The upper section of Nathan Creek provides excellent spawning and rearing habitat.

Lower Nathan Creek supported a small chum stock prior to 1966.

Table 1. Mean salmon escapements to Nathan Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	125	25[1]
1967-1971	145	0
1972-1976	925	0
1977[2]	700 (750)	0
1978[2]	1100 (1200)	0

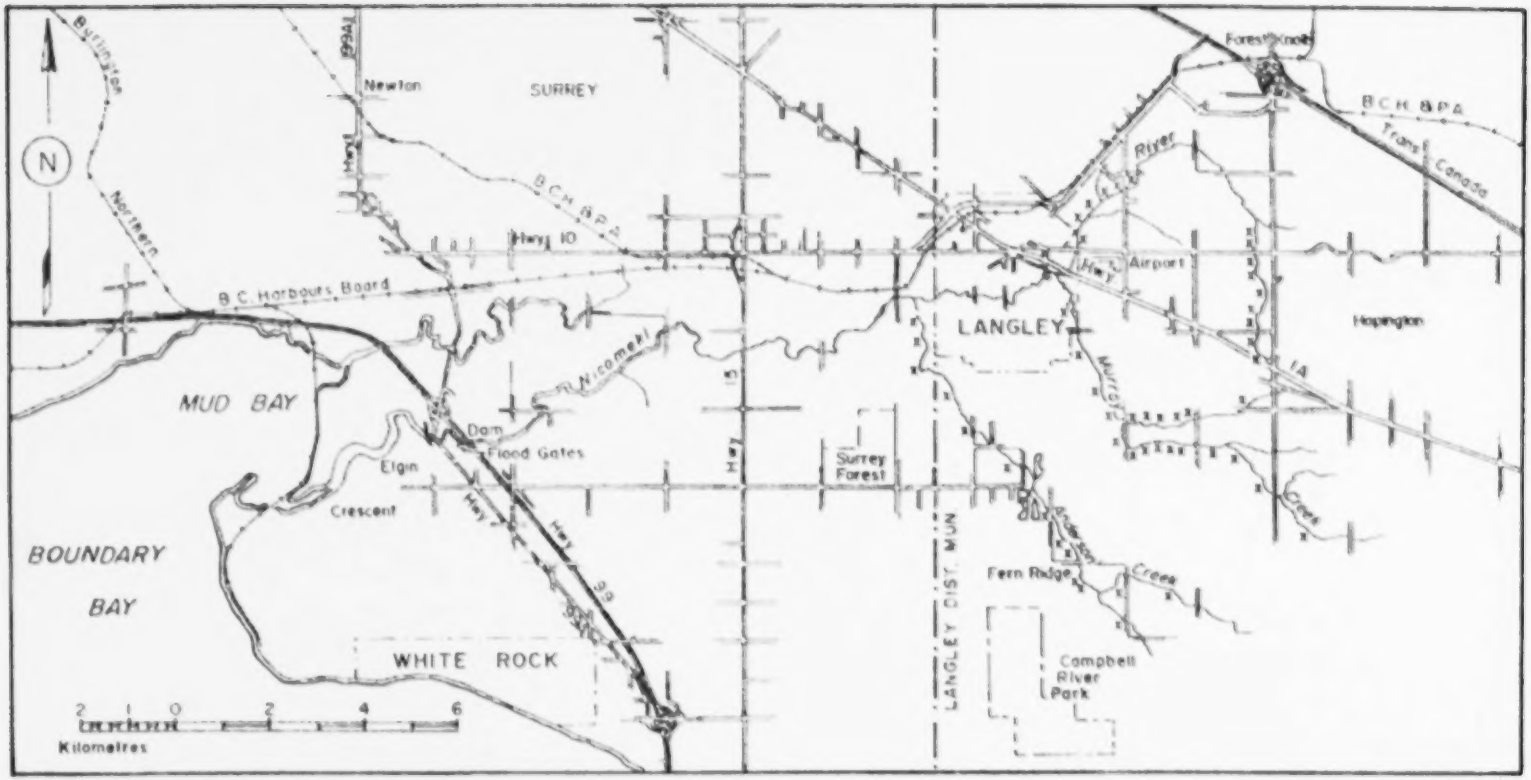
1. Chum have not been sighted since 1965.
2. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Nathan Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Late November	Late December
	1977	Early November	Early December	Late January
	1978	Late October	Early December	Mid January

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Nathan Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
43	Male	465	4	3.3	--	0	--
	Female	478	7	5.8	465	4	3.4
32	Male	462	57	47.1	442	58	49.1
	Female	481	53	43.8	468	50	42.4
22	Male	-	0	-	278	5	4.2
Combined	Male	457	104	55.6	438	99	50.0
	Female	477	83	44.4	470	99	50.0


N
Burlington
Northern
Newton
SURREY
Hwy 15
B.C.H. & P.A.
Hwy 10
B.C. Harbours Board
MUD BAY
Nicomekl
Dam
Flood Gates
Elgin
Crescent
BOUNDARY
BAY
WHITE ROCK
Hwy 99
Hwy 15
Surrey
Forest
LANGLEY DIST. MUN
LANGLEY
Forest Knoll
B.C.H. & P.A.
Trans Canada
River
Hwy 1
Airport
Hwy 1A
Hopington
Murrayville
Creek
Fern Ridge
Creek
Campbell
River
Park
2 1 0 2 4 6
Kilometres

NICOMEKL RIVER

LOCATION

Flows west for approximately 33 km entering Mud Bay, north of White Rock.

STREAM TYPE

Nicomekl River and tributaries Anderson, Murray and Trigg Creeks originate in an uplands area near Langley and drain a watershed of 177 km^2. The upper parts of the system flow across a gently sloping plateau draining primarily agricultural and residential land. The Nicomekl then enters the lowland area and for the remaining 21 km has a 'slough' form as it meanders across the floodplain. Gravel deposits are confined to the upper parts of the main tributaries and mainstem, as well as in parts of three lower tributaries.

OBSTRUCTIONS

Floodgates located 4 km upstream (at Hwy. 99A) close during high tide, blocking fish passage. Culvert and bridge crossings impede fish passage at several upstream sites, however improvements were underway in 1978.

WATERSHED UTILIZATION

The Serpentine - Nicomekl floodplain is one of the most important horticultural areas in B.C. Most of the lower 20 km has been diked and tidegates on the lower river, replaced in 1974, prevent seawater contamination of the large volumes of water withdrawn for irrigation. Urban and suburban development of the upland area has accelerated in recent years, with 24 subdivisions approved between 1974 and 1978. These developments have destabilized runoff patterns causing reduced minimum flows, and scouring and streambank erosion at high flows. In 1977 and 1978 the Agricultrual Resource Development Association, in conjunction with the Fish and Wildlife Branch and Department of Fisheries conducted a management study on this watershed, however no report has been issued.

A heavy sports fishery exists on the river, and prior to 1954 a commercial net fishery operated near the mouth. The B.C. Game Dept. introduced cutthroat trout in 1933, however it is doubtful that this introduction has influenced present distributions.

FISHERIES RESOURCE

Nicomekl River system coho spawn in the mainstem and in several tributaries. Mainstem spawning occurs between kms 21 and 23, and between kms 26 and 30. Coho also spawn in the following tributaries: in Anderson Creek between kms 0.5 and 10.6; in Murray Creek from 1.0 km to 8.6 km upstream, including the lower 1.5 km of its tributary, Trigg Creek; in the lower 0.3 km of Elgin Creek, which joins the Nicomekl approximately 4 km upstream; and coho spawning is scattered through two small lower tributaries.

Rearing potential is good in certain areas, but may be limited by the water quality effects of urban storm water runoff, and by low summer flows which are aggravated by heavy irrigation demand. The coho scale pattern shows relatively good freshwater growth, and some estuarine utilization by this stock.

ENHANCEMENT OPPORTUNITIES

A management study conducted in 1977 - 1978 by the Agricultural Resource Development Association, the Fish and Wildlife Branch, and the DFO Habitat Protection Division was to have included recommendations for enhancement. A report has yet to be issued.

Excellent spawning habitat in the lower reaches of Anderson Creek.

Disturbed habitat in upper Anderson Creek.

Table 1. Mean salmon escapements to the Nicomekl River System, 1962 to 1978.

Year	Coho
1962-1966	1600
1967-1971	1135
1972-1976	2900
1977[1]	3500 (3400)
1978[1]	600 (1500)

1. Bracketed figures are from the fishery officer escapement estimates.

Table 2. Timing of salmon spawning in the Nicomekl River System, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Late November	Late December
	1977	Late October	Mid November	Late January
	1978	Late October	Mid December	Late January

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Nicomekl River System coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Male	538	2	4.2	433	2	7.4
	Female	475	1	2.1	490	3	11.1
3_2	Male	472	26	54.2	439	10	37.0
	Female	499	19	39.5	470	12	44.4
2_2	Male	-	0	-	--	0	--
Combined	Male	480	35	58.3	446	22	52.4
	Female	499	25	41.7	477	20	47.6

Table 4(a). Monthly mean daily discharges in m^3/sec for Anderson Creek, metered at the confluence with Nicomekl River (Station No. 08MH104).

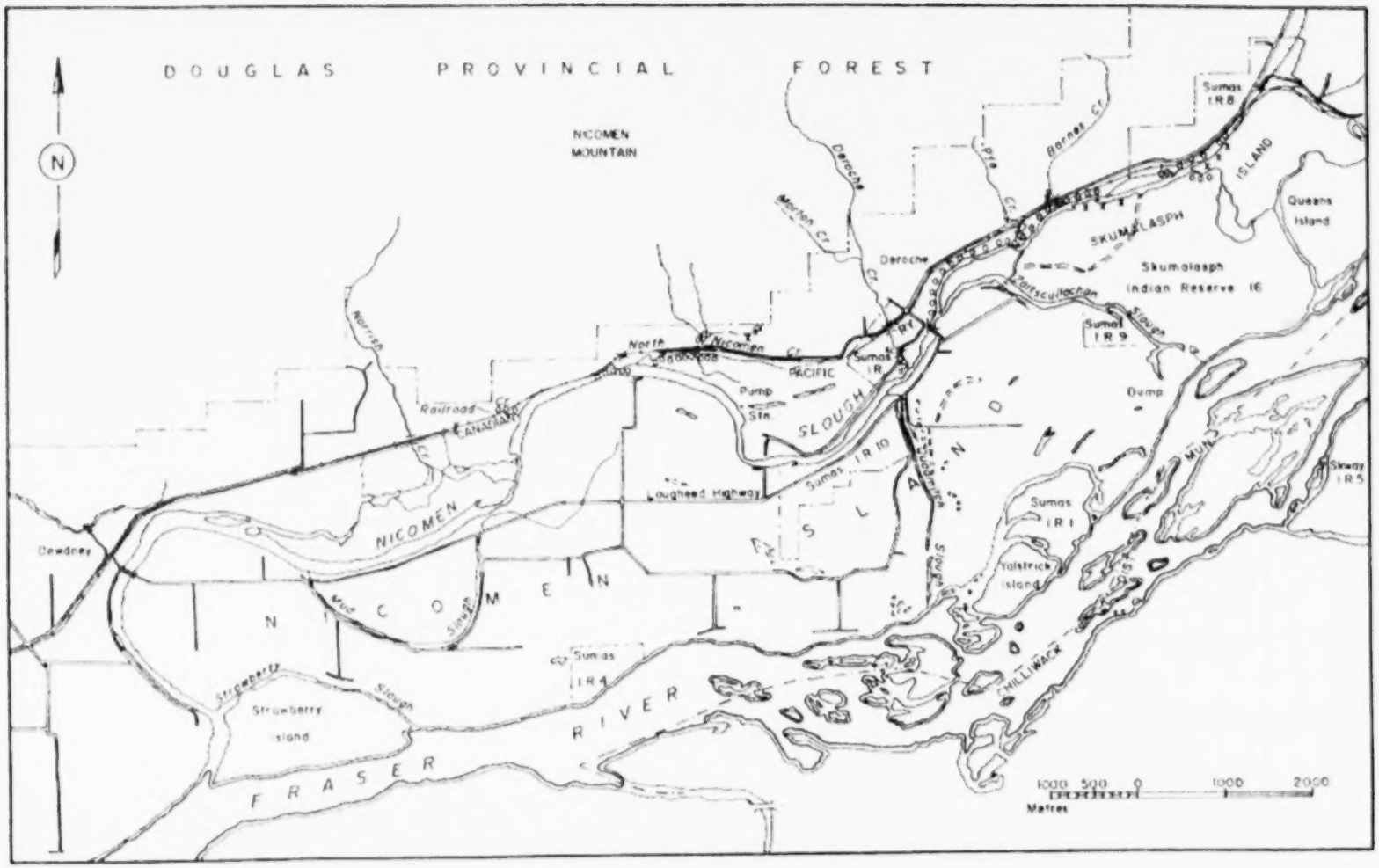
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	2.1	1.7	0.8	0.7	0.3	0.3	0.2	0.2	0.2	0.2	0.4	1.1	10.4(02/12)	0.2(11/10)
1974	1.7	2.2	1.1	0.8	2.1	0.3	0.1	0.2	0.2	0.2	0.3	1.7	13.4(12/02)	0.1(09/26)
1973	1.1	0.7	0.7	0.3	0.2	0.2	0.2	0.1	0.1	0.1	1.1	1.5	8.3(02/03)	0.1(11/15)
1972	1.9	2.1	2.1	1.0	0.4	0.2	0.4	0.2	0.2	0.2	0.5	1.9	14.9(11/28)	0.2(10/18)
1971	2.4	1.6	1.4	0.6	0.2	0.3	0.2	0.2	0.2	0.3	1.3	1.9	17.2(12/17)	0.1(07/01)

Table 4(b). Monthly mean daily discharges in m^3/sec for Nicomekl River, metered below Murray Creek (Station No. 08MH105).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	5.5	4.1	2.3	2.1	0.5	0.7	0.3	0.3	0.5	0.6	1.9	3.3	18.2(02/12)	0.2(10/17)
1974	5.0	4.5	2.8	1.7	1.3	0.7	0.3	0.2	0.1	0.2	1.6	4.8	22.5(12/02)	0.1(08/06)
1973	2.7	1.9	1.8	0.4	0.2	0.2	0.2	0.1	0.2	0.4	3.5	4.3	18.9(02/03)	0.1(09/22)
1971	4.7	5.2	5.1	2.5	0.7	0.2	1.2	0.2	0.3	0.3	1.9	5.6	21.9(11/28)	0.1(08/15)
1970	4.5	3.8	4.1	1.2	0.3	0.7	0.3	0.1	0.2	1.3	4.7	4.0	21.5(12/26)	0.1(07/05)

Table 4(c). Monthly mean daily discharges in m^3/sec for Murray Creek, metered at the 216th Street crossing (Station No. 08MH129).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	1.83	1.16	0.68	0.63	0.12	0.14	0.02	0.03	0.05	0.08	0.40	0.87	7.0(01/15)	0.01(08/03)
1974	1.72	1.64	0.96	0.57	0.35	0.16	0.01	0.01	0.10	0.03	0.40	1.54	9.6(02/03)	0.04(07/30)
1973	0.87	0.60	0.51	0.10	0.03	0.02	0.02	0.01	0.02	0.10	1.32	1.50	7.0(11/28)	0.01(08/01)
1972	1.50	1.87	1.87	0.86	0.17	0.02	0.29	0.02	0.03	0.04	0.59	2.19	10.3(12/25)	0.01(08/03)
1971	2.26	1.36	1.36	0.40	0.05	0.17	0.02	0.01	0.01	0.33	-	-	12.7(01/26)	0.01(07/27)


DOUGLAS PROVINCIAL FOREST
N
NICOMEN MOUNTAIN
Sumas IR8
ISLAND
Queens Island
SKUMALASPH
Skumalasph Indian Reserve 16
Sumal IR9
Pump Sta.
SLOUGH
Sumas IR10
Sumas IR1
Tolstrick Island
Sumas IR4
Strawberry Island
Dewdney
NICOMEN
FRASER RIVER
CHILLIWACK
Railroad
Loughheed Highway
1000 500 0 1000 2000
Metres

NICOMEN SLOUGH AND TRIBUTARIES

LOCATION

Flows west for approximately 22 km entering Fraser River east of Mission.

STREAM TYPE

Nicomen Slough is a former side channel of the Fraser River which flows in a broad, diked channel through agricultural land. Streamside vegetation is predominantly grass with deciduous forest in the upper 2 km. Excellent gravel deposits exist through much of the slough, however backflooding during peak Fraser River discharges coupled with reduced flows have resulted in the deposition of a thick layer of silt over most of the slough bottom. As a result, clear gravel exists only at channel constrictions and in areas with upwelling water, especially above Deroche.

Several streams tributary to Nicomen Slough are important salmon producers:

NORRISH CREEK (described elsewhere in this reports).

RAILROAD CREEK is a small groundwater-fed creek which meanders through exposed farmland for approximately 300 m, entering Nicomen Slough east of the East Norrish confluence. Chum spawn throughout with reported escapements of up to 600 fish. The spawning area in this tributary was recently rehabilitated by SEP (Lister et al 1980).

NORTH NICOMEN CREEK (local name) flows west for approximately 1.6 km entering the slough 4.5 km west of Deroche. In the lower 1.4 km this small creek flows in an unprotected channel through farm fields. Gravel deposits exist in a series of upwelling pools between 0.6 km and a marsh located 0.75 km upstream. Superimposition of chum spawners was observed during the survey, especially in 1978 when more than 1500 chums spawned in this creek. Other problems include a total removal of streamside vegetation, unstable banks which are aggravated by unlimited cattle access, and intermittent summer flows.

DEROCHE (CRAZY) CREEK is a small stream (Table 4) which flows in a southerly direction for approximately 6 km entering the slough 200 m west of Deroche. Gravel deposits exist in the lower 300 m above which the gradient precludes further access. Previous escapements have averaged less than 25, however this survey recorded 400 coho spawners. This fluctuation may be attributable to disruption of spawning grounds by ongoing gravel removal.

PYE CREEK flows in a southerly direction for approximately 3 km entering the slough 1.3 km east of Deroche. Coho spawning occurs up to the impassable culvert and boulder trap 300 m upstream. Stream flow is highly variable during the spawning period. Dead spawners have been recovered from dry pools in both years of this program.

BARNES CREEK flows in a southerly direction for 3 km entering the slough 1.9 km east of Deroche. Only the lower 25 m below the CPR culvert is passable to coho spawners.

SIDDLE CREEK (described elsewhere in this report).

A major chum spawning area east of Deroche.

Coho spawning habitat in Pye Creek.

OBSTRUCTIONS

Flood control dams at the head of Nicomen, Zuitscullachan, and Quaamitch Sloughs block all but seepage flow from the Fraser River.

WATERSHED UTILIZATION

The Nicomen Slough watershed is primarily an agricultural area. In 1937 the upper ends of Nicomen and feeder sloughs were dammed, eliminating inflow from Fraser River and subsequently causing heavy siltation and extensive aquatic plant growth. Dikes were constructed along the length of the slough in 1949, and Canadian Forest Products operates a booming area and shingle

mill near Dewdney. The mountains to the north were logged early in the century.

FISHERIES RESOURCE

Chum salmon spawn in several primarily groundwater-fed areas throughout the upper slough: in a short section at the confluence of North Nicomen Creek; between kms 0.6 and 0.75 in North Nicomen Creek; at groundwater extrusions and channel constrictions from the Deroche highway bridge (14 km) upstream for approximately 4 km.

Coho spawning is scattered above the Deroche bridge and is heavy in the accessible portions of Pye, Deroche and Barnes Creeks.

Heavy siltation, aquatic plant growth, and low flows have degraded the quality of salmonid rearing habitat, however rearing potential still appears to be good. Limited available data indicates that prior to the damming of Nicomen Slough inflows in 1937, this system was a significantly greater chum producer than at present (Palmer 1972).

ENHANCEMENT OPPORTUNITIES

An opportunity may exist to restore the chum and pink stocks to historic levels through flow manipulation and silt removal, however further study is required to determine the cost effectiveness of such a scheme.

The chum spawning areas in North Nicomen Creek should be enlarged and rehabilitated using the methods described by Lister et al. (1980).

Table 1. Mean salmon escapements to the Nicomen Slough System, 1962 to 1978. (Note: Escapements include all tributaries except Norrish, Railroad, and Siddle creeks. For separate estimates, see Appendices 2 and 3)

Year	Coho	Chum
1962-1966	680	1550
1967-1971	240	980
1972-1976	295	2510
1977[1]	1500	5000 (6500)
1978[1]	500 (750)	6000 (3500)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in the Nicomen Slough system, 1970 to 1978. (Note: Minor differences in timing which exist between areas are reported in Appendices 2 and 3).

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	October/November	December	January
	1977	Mid November	Early/Mid December	January/February
	1978	November	Early/Mid December	February/March
Chum	1970-1976	October	November	December/January
	1977	October	Late November	Early January
	1978	Late October	Early December	Early January

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Nicomen Slough coho. (Note: Includes Derache, Pye and Barnes creek samples. For separate age analysis, see Appendices 2 and 3)

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
43	Male	425	1	1.6	439	1	0.8
	Female	-	0	-	457	5	4.1
32	Male	484	22	34.4	473	45	36.9
	Female	482	38	59.4	477	62	50.8
22	Male	268	3	4.7	325	9	7.4
Combined	Male	490	31	40.8	446	71	47.3
	Female	481	45	59.2	474	79	52.7

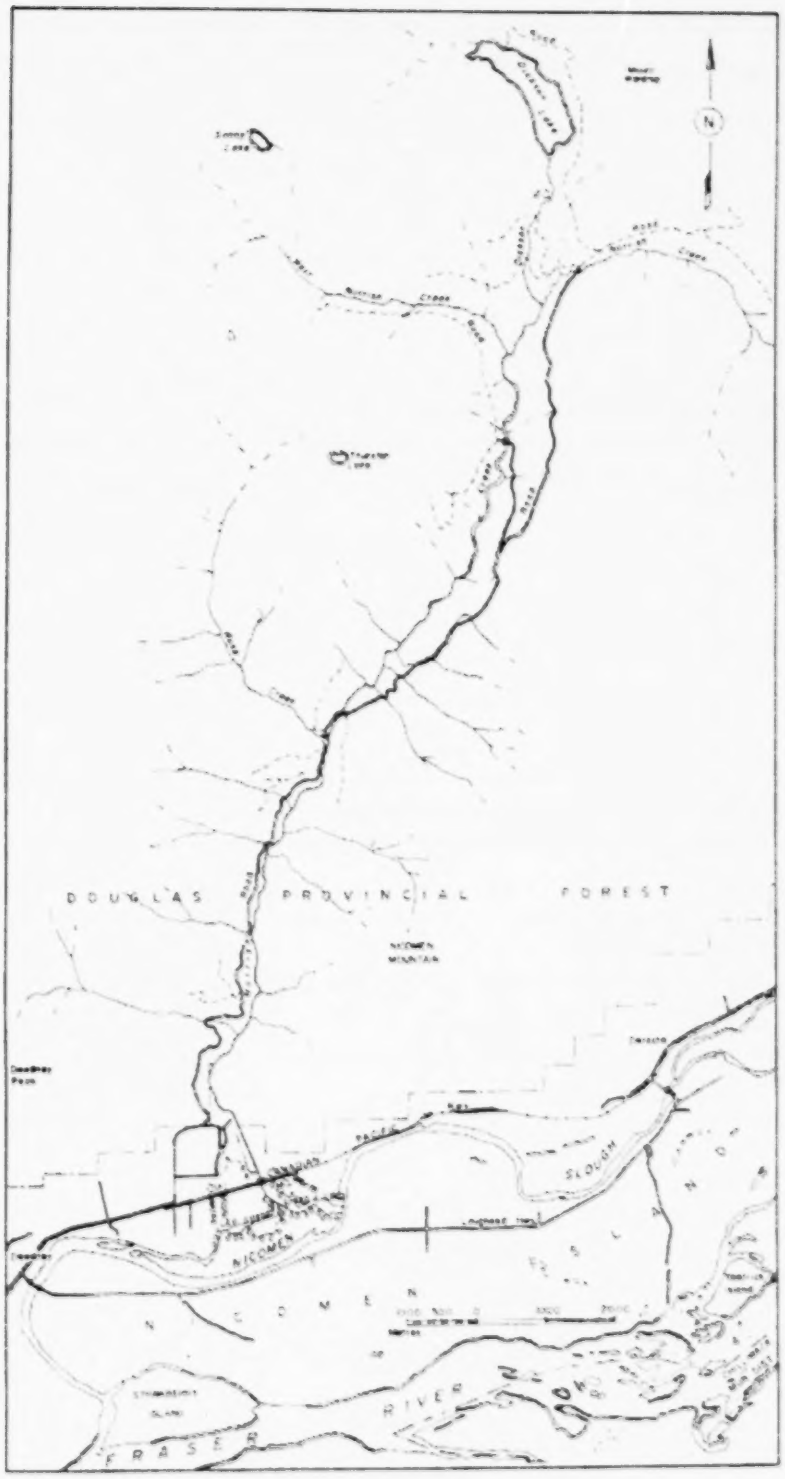
Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Nicomen Slough chum salmon. (Note: All spawning areas grouped. For a separate analysis, see Appendices 2 and 3).

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
5	Male	625	1	1.1	659	2	0.3
	Female	615	3	3.3	628	2	0.3
4	Male	604	29	31.5	598	244	33.5
	Female	580	39	42.4	572	297	40.7
3	Male	533	6	6.5	558	88	12.1
	Female	534	14	15.2	533	96	13.2
Combined	Male	593	36	39.1	587	345	46.4
	Female	590	56	60.9	563	399	53.6

Table 4. Monthly mean daily discharges in m^3/sec for Derache Creek (Station No. 08MH070).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1964	0.5	0.3	0.3	0.6	--	-	-	-	-	-	-	-	-	-
1963	0.2	0.3	0.1	--	-	-	-	-	nil	0.1	0.7	1.4	e 7.9(11/26)	0(01/28)
1962	1.5	0.8	0.2	0.4	--	-	-	-	nil	nil	0.4	1.1	6.6(01/07)	0(09/01)
1961	1.3	1.8	0.4	0.6	--	-	-	-	nil	0.4	0.4	1.0	e14.2(02/21)	0(09/01)
1960	-	0.4	0.2	0.5	--	-	-	-	nil	0.4	0.5	0.5	4.8(01/29)	0(01/22)

e estimated


DOUGLAS PROVINCIAL FOREST
SLOUGH
ALOUETTE
FRASER RIVER

NORRISH (SUICIDE) CREEK

LOCATION

Flows south for approximately 25 km entering the west end of Nicomen Slough.

STREAM TYPE

The Norrish Creek system includes Dickson Lake and several major tributaries which drain a mountainous watershed of 123 km^2. Arising at an elevation of 1150 m, it flows through a steep canyon for much of the upper 20 km. Emerging from the canyon at approximately 4.5 km, the creek flows into a 2.4 km long diked channel before entering a wide alluvial fan where the creek forks. East Norrish Creek, and West Norrish Creek above 1.3 km, are extensively braided and contain excellent gravel deposits. The lower 1.3 km of the west branch has slough-like nature.

The west branch is joined by Inches Creek (not surveyed). The east branch is joined by Worth Creek, a 0.9 km long spring-fed stream which enters Norrish Creek 1 km upstream. Worth is a run for most of its length, with spawning occuring primarily n a marshy area in the upper 100m. Enforcement officers indicate that 1977 is the first time in 15 years that chum have spawned in upper Worth Creek. (Note: Escapements recorded for Worth Creek prior to 1977 are actually East Norrish Creek escapements and have been included there in this report).

Acting on information from this survey, the Small Projects group of SEP rehabilitated much of Worth Creek. A full description and assessment of this work was reported by Lister et al (1980).

OBSTRUCTIONS

A rockfalls located near the Rose Creek confluence is impassable to migrating salmonids.

WATERSHED UTILIZATION

Extensive logging over the last sixty years has destabilized this system resulting in very rapid runoffs. Canadian Forest Products is currently logging the watershed and has plans through 1985 to log the headwaters and upper tributaries.

Shifting gravel has threatened the CPR mainline crossing since the turn of the century, and as early as 1948 CPR, among others, was removing gravel from the stream-bed above the railroad crossing and in the west branch. From 1966 to 1970 a gravel processing plant operated above the railroad crossing, and in 1966 CPR diked and channelized the creek up to the canyon confining it to a single channel and cutting off the west channel which was previously used by coho spawners. The CPR continued grading the stream-bed and armouring the dikes until September 1973, after which such work was discontinued.

In 1969, the City of Mission was issued a water licence to remove 2.5 million gallons/day from Norrish Creek at the Rose Creek confluence. Further development of this water licence has been stayed due to the formation of the Central Fraser Valley Water Commission. That agency applied for a licence for 16 cfs in September, 1978.

A more detailed historic summary is reported by Cleugh et al (1979).

Approximately 2.4 kms of Norrish Creek has been channelized and diked to protect the CPR crossing (background).

Chum spawn heavily throughout the west branch of Norrish Creek.

FISHERIES RESOURCE

Norrish Creek chum spawn throughout the east branch, and in the west branch above 1 km. Chum also spawn heavily in the upper 100m of Worth Creek.

Coho spawn in the upper sections of each branch, and at the outlet of a former side channel diked off by CPR in 1966. (approximately 1 km above branch point). Some spawning may occur in the canyon, however access problems precluded survey of this section.

Coho rearing distribution in Norrish Creek was described by Cleugh, et al. (1979). Rearing is confined primarily to the side channels and pools in the lower reaches. The distribution and growth of these fish was dependent primarily on streamflows.

ENHANCEMENT OPPORTUNITIES

The Norrish Creek watershed has been the site of considerable enhancement effort to date. The Department of Fisheries has conducted stream improvement work in Inches Creek since 1965, leading to the development of a pilot hatchery in 1970 (Fedorenko and Bailey, 1980). When completed, this facility will serve as a central hatchery for the chum, coho, and cutthroat stocks in the Norrish/Nicomen area.

The chum spawning area in Worth Creek was rehabilitated in 1979, with egg-to-fry survivals in excess of 30% reported for the 1979 brood (Lister et al. 1980).

A further opportunity for enhancement may exist in the reopening and rehabilitation of the mainstem side-channel which was diked in 1966 (see above). The provision of a stable spawning area for coho may offset losses which occur during the violent winter freshets observed in this sytem.

Table 1. Mean salmon escapements to the Norrish Creek system, 1962 to 1978. (Note: for individual escapements to the East and West branches, see Appendices 2 and 3).

Year	Coho	Chum
1962-1966	350	135
1967-1971	580	1930
1972-1976	320	2550
1977[1]	150 (400)	3500 (4000)
1978[1]	400	6500 (3500)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in the Norrish Creek system, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	November	December	January
	1977	Mid November	Late December	Early February
	1978	Late November	Mid January	Late February
E. Branch Chum	1970-1976	November	December	December
	1977	October	Early December	Late January
	1978	Mid October	Mid December	Late January
W. Branch Chum	1970-1976	October	November	January
	1977	October	Mid December	Mid January
	1978	Late September	Mid December	Early January

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Norrish Creek System coho salmon.

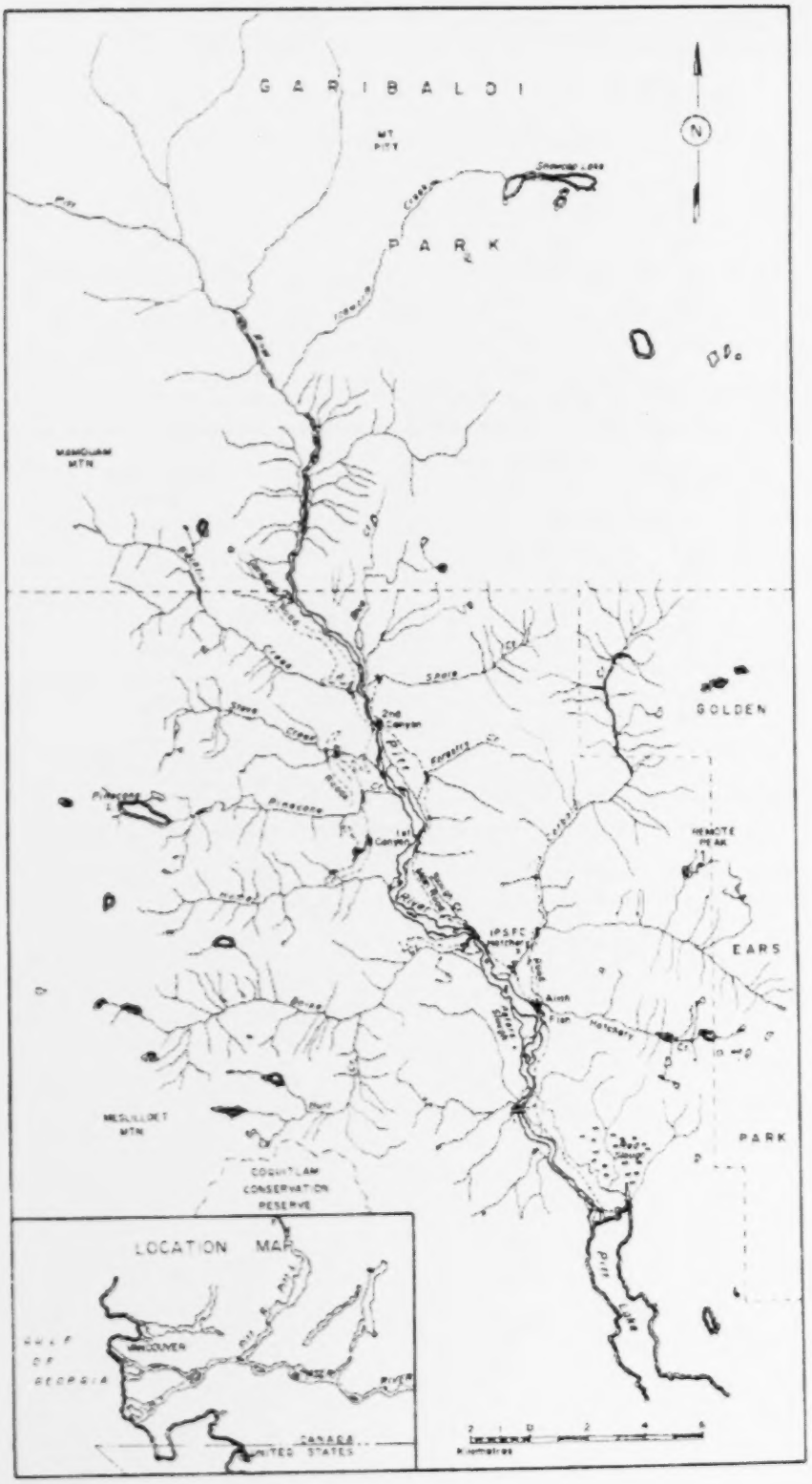
Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
43	Male	-	0	-	--	0	--
	Female	-	0	-	510	1	2.2
32	Male	498	8	66.7	482	18	40.0
	Female	507	3	25.0	465	25	55.6
22	Male	281	1	8.3	298	1	2.2
Combined	Male	480	11	73.3	474	28	44.4
	Female	523	4	26.7	469	35	55.6

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Norrish Creek System chum salmon.

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
5	Male	617	4	3.3	628	12	2.5
	Female	625	2	1.7	600	4	0.8
4	Male	611	37	30.9	597	187	38.5
	Female	588	48	40.0	576	206	42.4
3	Male	562	22	18.3	554	35	7.2
	Female	531	7	5.8	538	42	8.6
Combined	Male	595	63	52.5	591	242	48.4
	Female	582	57	47.5	571	258	51.6

Table 4. Monthly mean daily discharges in m^3/sec for Norrish Creek, metered at the south end of the canyon (Station No. 08MH058).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	ov	Dec	Daily Discharge Max	Daily Discharge Min
1976	16.8	8.1	8.7	13.5	22.4	15.9	8.1	6.9	7.2	4.6	8.2	19.2	67.4(12/26)	1.4(10/23)
1975	12.7	6.3	9.1	7.4	19.0	13.6	4.1	4.4	2.6	19.0	27.4	30.6	152.6(12/02)	1.0(08.21)
1974	26.0	12.0	17.5	17.1	19.7	24.1	10.6	2.8	1.6	1.6	15.3	18.5	83.3(01/14)	1.0(10/19)
1973	8.5	7.9	8.1	9.0	13.4	8.1	2.9	1.4	1.4	12.0	12.1	20.8	62.3(11/28)	0.8(09/16)
1972	12.7	19.9	34.3	26.8	26.2	17.9	13.6	2.4	8.6	3.2	11.8	25.7	87.6(07/12)	1.5(09/04)


GARIBALDI
PARK
GOLDEN
EARS
PARK
MT. PITT
MOUNT GARIBALDI
MT. MEAGER
MT. MILLIKET
COQUITLAM CONSERVATION RESERVE
LOCATION MAP
GULF OF GEORGIA
VANCOUVER
CANADA
UNITED STATES

UPPER PITT RIVER

LOCATION

The Upper Pitt River flows south for 52 km entering Pitt Lake, north of Haney.

STREAM TYPE

The Upper Pitt River is a glacial system which arises near Isosceles Peak at an elevation of 1710m and drains a watershed of approximately 780 km^2. The river flows for much of its length in a braided, shifting channel across a wide, flat-bottomed valley bounded by steep mountains. The river is characterized by long rapids and riffles with frequent deep pools. There are no obstructions to salmonid migrants in the lower 40 km, however optimum spawning and rearing habitat is limited to the lower reaches of the tributaries and to the more stable side and back channels.

The Pitt River hydrograph reflects a dominant summer glacial melt modified by fall and spring precipitation inputs. Violent flow fluctuations which commonly occur in the fall can be attributed to widespread clearcut logging practices, an absence of headwater lakes, and to the steep gradient throughout the watershed. Gravel and debris transport associated with these high discharges commonly causes channel shifts which limit the value of the mainstem as spawning and rearing habitat.

OBSTRUCTIONS

There is a series of impassable rapids and falls located approximtely 40 km upstream.

WATERSHED UTILIZATION

Forest harvesting has been the only significant human activity n the Upper Pitt River watershed. B.C. Forest Products, which has development plans through to the end of the decade, maintains a network of roads in the watershed and operates a logging camp at Alvin. Much of the benchland was logged early in the century and is now covered with deciduous forest. The B.C. Forest Service (Corrections Branch) is conducting an alder thinning program in these areas.

The Department of Fisheries operated a sockeye hatchery on Fish Hatchery Creek from 1914 until the hatchery program was abandoned in 1936. The International Pacific Salmon Fisheries Commission has operated a five million egg capacity sockeye salmon hatchery on Corbold Creek since 1960.

Other activities have been discouraged by the relative remoteness of the area (inaccessible by road) and by the establishment in 1920 of Garibaldi Park, which includes the upper portion of the watershed.

FISHERIES RESOURCE

Upper Pitt River coho enter the river as early as mid September and hold in mainstem pools until mature. Spawning occurs in the lower sections of most tributaries, especially Boise and Blue Creeks, and in the few stable side channels. No mainstem coho spawning has been observed, however there are unconfirmed reports of spawning in the mainstem above the third canyon.

Chinook spawn primarily in the lower 1 km of Blue Creek, although a small group also spawns in a stable side channel immediately below the Homer Creek confluence. Spawners have been sighted in Corbold Creek and in the Pitt River mainstem between Boise Creek and the first canyon, however extremely poor sighting conditions have hindered enumeration in these areas. Boise Creek historically supported a chinook stock, however few have been noted in recent years.

Upper Pitt River valley. Note the extensive braiding of the river and the many logged off areas.

In the lower 20 km the channel is braided and commonly shifts from year to year.

Chum salmon spawn in a side channel, immediately opposite Alvin, known as Peter's Slough, however the inconsistant pattern of sightings suggest that these fish may be straying from Alouette River or Widgeon Creek.

Sockeye spawn primarily in the mainstem of the Pitt River. IPSFC personnel conduct a Peterson disc tagging program during their annual egg take procedures.

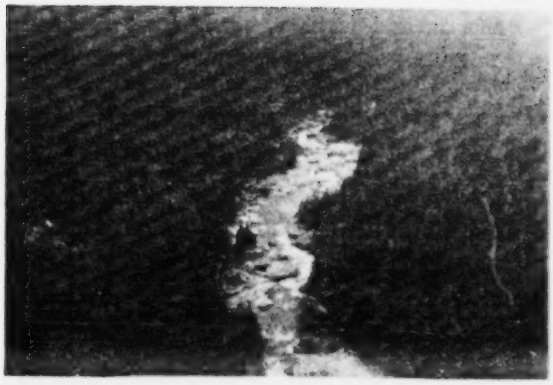
The major rearing areas were described by Schubert (unpublished) and are located primarily in protected mainstem

side channels and in the lower reaches of most tributaries. Boise, Slough and Blue Creeks are the most productive areas.

ENHANCEMENT OPPORTUNITIES

Current enhancement in the Upper Pitt River drainage is limited to a sockeye hatchery which was established by the IPSFC in 1960 in order to offset egg losses resulting from a destabilization of the mainstem spawning areas. This instability in flows may also have contributed to the observed decline in the chinook stock.

Sufficient ground and surface water is available for a major facility; potential construction sites are available on a number of benchland areas. As an interim measure, an incubation box is recommended to rehabilitate the severely depressed chinook stock.



Rapids and falls in the upper reaches. Note the undisturbed forest cover within Garibaldi Park.

Table 1. Mean salmon escapements to the Upper Pitt River, 1962 to 1978.

Year	Coho	Chum	Chinook	Sockeye
1962-1966	2,800	788[3]	1,530	14,330
1967-1971	7,900[1]	-	2,070	14,852
1972-1976	3,000	400[4]	610	24,512
1977[2]	7,500 (8,000)	-	- (700)[5]	13,687
1978[2]	17,500 (40,000)	25	150	24,835

1. 1971 escapement was 35,000.
2. Bracketed figures are fishery officer escapement estimates.
3. 1962 and 1966 only.
4. 1976 only.
5. Chinooks were not surveyed during 1977.

Table 2. Timing of salmon spawning in the Upper Pitt River, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho[1]	1970-1976	Early November	Early December	Late December
	1977	Mid November	Mid December	Late January
	1978	Mid November	Late December	Early February
Chum	1970-1976	October	Mid October	Early November
Chinook	1970-1976	Late August	Early September	Late September
	1978	Early August	Mid August	Late September
Sockeye	1970-1976	September	Mid September	Late September

1. Coho arrive in the system in mid September.

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1978 Upper Pitt River coho salmon.

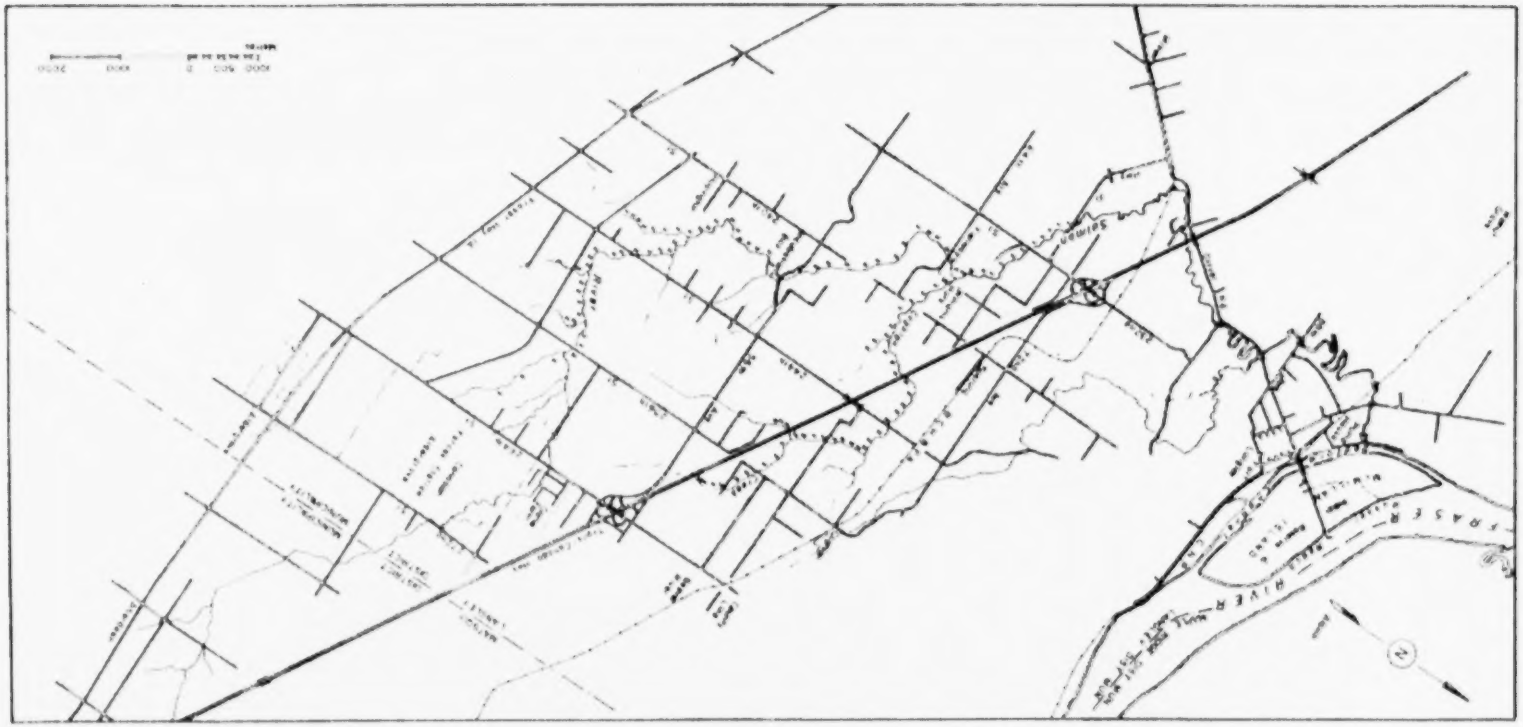
Age	Sex	1978		
		Mean Length(mm)	N	%
4_3	Combined	-	0	-
3_2	Male	513	5	38.5
	Female	521	8	61.5
2_2	Male	-	0	-
Combined	Male	493	6	40.0
	Female	516	9	60.0

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1978 Upper Pitt River chinook salmon.

Age	Sex	1978		
		Mean Length(mm)	N	%
3_2	Male	450	2	50.0
4_1	Male	765	2	50.0
Combined	Male	607	4	100
	Female	-	0	-

Table 4. Monthly mean daily discharges in m^3/sec for the Upper Pitt River, metered at the outlet of the first canyon (Station No. 08MH017).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge	
													Max	Min
1965	14.7	16.4	17.6	34.0	54.9	104.8	98.0	84.1	-	-	-	-	-	-
1964	19.2	13.5	11.6	23.2	52.4	118.9	170.2	109.3	84.4	66.0	32.6	20.0	325.7(07/15	9.9(03/09)
1963	19.3	60.3	20.4	25.3	58.3	87.2	99.1	75.0	-	-	-	-	308.7(10/13)	--
1962	11.9	19.3	8.4	37.4	48.7	106.8	107.0	103.7	60.0	74.2	58.3	50.7	230.8(08/20)	5.8(02/27)
1961	38.8	26.5	14.7	13.5	46.7	101.7	81.3	51.5	28.9	16.5	11.3	8.7	232.2(01/15)	7.6(09/26)
1960	15.3	19.7	19.8	41.1	60.3	102.0	114.4	74.8	58.9	57.5	36.8	25.1	165.4(01/16)	7.1(01/10)



SALMON RIVER

LOCATION

Flows in a northerly direction for approximately 33 km entering Fraser River west of Fort Langley.

STREAM TYPE

Salmon River and its tributary, Coghlan Creek, originate in a low lying agricultural area and have a combined drainage of 85 km^2. The upper tributaries are marshy and flow through shallow valleys. In the middle stretches, the river flows across gently sloping terrain in a meandering, protected channel. The stream has riffle/pool form with excellent gravel deposits between kms 10 and 22. In the final 10 km the gradient decreases and the channel is deep with a sand and silt bottom and forms a series of tortuous meanders through meadowland.

Coghlan Creek, which joins the mainstem at km 14, has excellent gravel deposits in the lower 4.5 km.

OBSTRUCTIONS

The 64th Avenue fishway requires a more effective mechanism to guide migrants to the downstream entrance.

On Coghlan Creek, an irrigation drop-structure located approximately 4.5 km upstream restricts coho passage at certain discharges.

All juvenile migrants must pass through the Salmon River Pumping Station. Flapper valves periodically close, preventing fish passage.

WATERSHED UTILIZATION

The Salmon River watershed is primarily an agricultural area with scattered residential development. Licenced water withdrawal has adversely influenced summer flows in recent years (Table 4), and ongoing land clearance has resulted in higher peak discharges and more frequent scouring.

Cutthroat trout were introduced into the system by the B.C. Game Department in 1933. In 1979, Salmon River coho were used as donor stock for an incubation box facility in the Alouette System. An incubation box installed in the Salmon River in 1980 will become operational in 1981.

FISHERIES RESOURCE

Salmon River coho spawn between kms 11 and 22, including the lower parts of several small tributaries. The lower 4.5 km of Coghlan Creek is heavily used, with scattered spawning beyond that point. Up to one-half the Salmon system coho escapement spawns in Coghlan Creek.

The rearing potential of the system is excellent. The rearing areas in the middle and upper reaches are protected and the summer flows are stable.

ENHANCEMENT OPPORTUNITIES

A number of habitat improvements were outlined by Paish (1979, 1980). Pumphouse modification should receive a high priority.

The middle reaches of the Salmon River provide excellent spawning and rearing habitat.

The 64th Avenue Fishway.

Table 1. Mean salmon escapements to Salmon River, 1962 to 1978.

Year	Coho
1962-1966	150
1967-1971	1095
1972-1976	2570
1977	3500
1978[1]	5500 (3500)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Salmon River, 1970 to 1978.

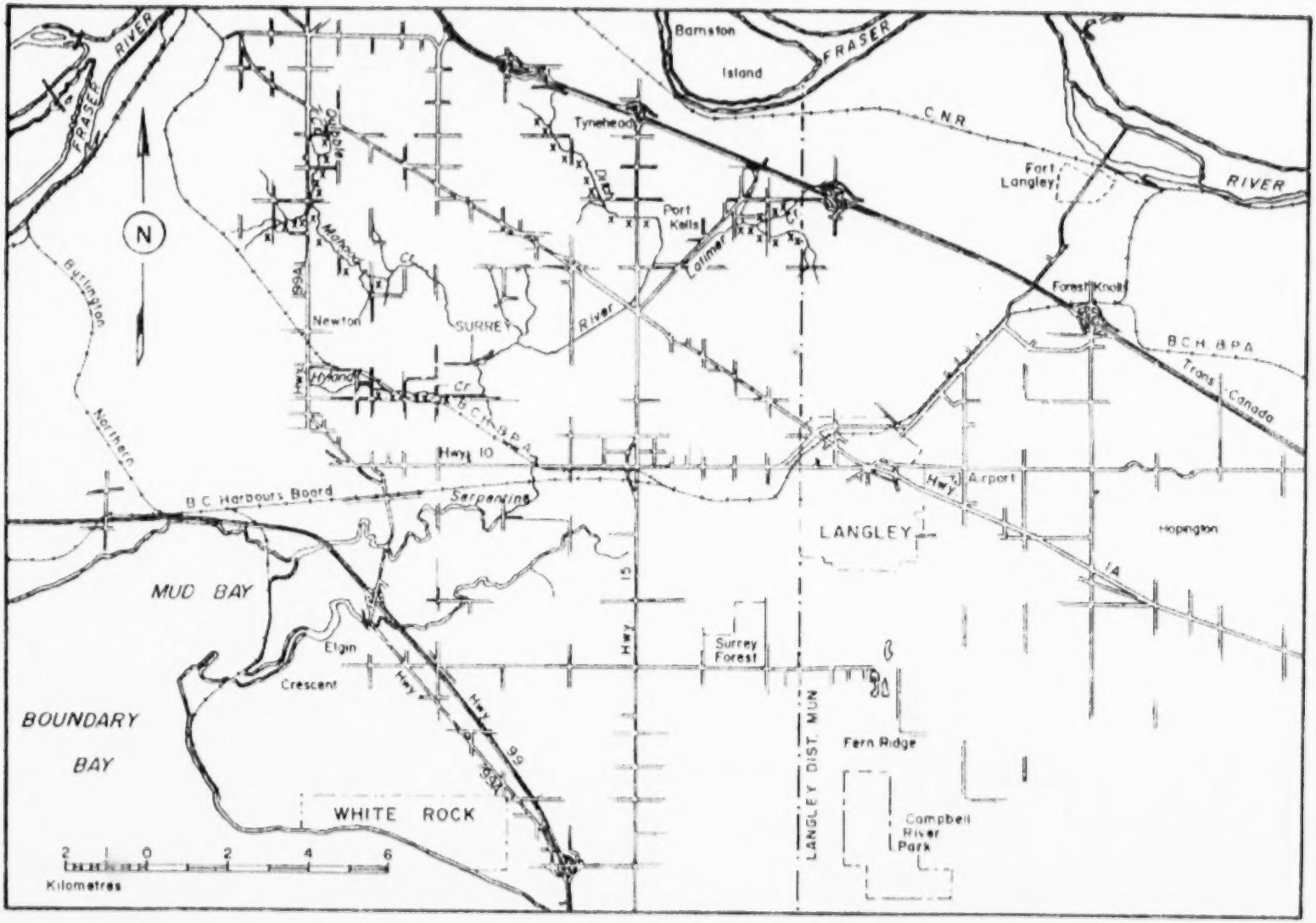
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Early December	Late December
	1977	Late October	Mid December	Early February
	1978	Early November	Mid December and Mid February	Late February

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Salmon River System coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
4_3	Male	458	9	5.2	417	1	0.6
	Female	495	1	0.6	507	6	3.4
3_2	Male	474	86	49.4	433	82	45.8
	Female	474	68	39.1	471	86	48.0
2_2	Male	300	10	5.7	282	4	2.2
Combined	Male	458	159	59.1	426	140	48.4
	Female	475	110	40.9	471	149	51.6

Table 4. Monthly mean daily discharges in m^3/sec for Salmon River, metered at the 72 Avenue crossing (Station No. 08MH090).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge	
													Max	Min
1974	3.7	3.8	2.4	1.6	1.2	0.6	0.3	0.2	0.2	0.2	1.1	3.2	24.9(02/03)	0.2(09/19)
1973	-	-	-	0.7	0.5	0.4	0.3	0.2	-	0.4	2.6	3.2	14.5(11/28)	--
1972	3.8	4.3	3.9	1.8	0.8	0.4	1.1	0.3	0.5	0.4	1.5	5.0	28.9(12/26)	0.2(08/09)
1971	4.5	3.4	3.1	1.2	0.5	0.8	0.5	0.3	0.3	1.0	3.7	4.0	32.3(12/17)	0.2(09/22)
1970	2.6	1.9	1.1	1.9	0.5	0.2	0.2	0.2	0.2	0.3	1.2	2.9	9.9(12/06)	0.2(08/21)


Barnston
Island
FRASER
RIVER
C.N.R.
Tynehead
Fort
Langley
RIVER
Port
Kells
Latimer
Cr.
Forest Knoll
N
Burlington
Northern
Newton
SURREY
River
B.C.H.&P.A.
Trans Canada
Hwy 10
B.C. Harbours Board
Serpentine
Hwy 1
Airport
LANGLEY
Hopington
MUD BAY
Elgin
Crescent
Hwy 15
Surrey
Forest
Hwy 99
BOUNDARY
BAY
WHITE ROCK
LANGLEY DIST. MUN.
Fern Ridge
Campbell
River
Park
2 1 0 2 4 6
Kilometres

SERPENTINE RIVER

LOCATION

Flows west for approximately 27 km, entering Mud Bay north of White Rock.

STREAM TYPE

Serpentine River and tributaries Hyland, Mahood, Bear, Fleetwood, Guibble and Latimer Creeks drain an extensively developed residential and agricultural watershed of 147 km^2. These creeks originate in marshy terrain in north Surrey, before flowing across a moderately sloping plateau. The lower 22 km of the Serpentine flows in ditches and diked channels through a lowland agricultural area. Spawning gravel exists in the upper parts of the tributaries and in a 3 km section of the mainstem located in the Tynehead area.

Water extraction for irrigation as well as land clearance for agricultural and residential purposes have contributed to destabilized flow patterns, resulting in scouring, bank erosion, siltation, and depressed summer flows.

OBSTRUCTIONS

Flood gates located at 1.4 km (Hwy. 99A crossing) are impassable when closed at high tide.

WATERSHED UTILIZATION

The Serpentine watershed is one of the most intensively developed agricultural areas in B.C. Developments associated with early agricultural activity included dredging of the lower river between 1920 and 1940, logging of the upper watershed in 1929, and a dredging operation in the central section near Fry's Corner in 1951. Cutthroat trout were introduced in the river by the B.C. Game Dept. in 1933, and a commercial net fishery operated in the lower river prior to 1948. In recent years, residential development has accelerated the rate of land clearance with 26 subdivisions approved between 1972 and 1978.

FISHERIES RESOURCE

Coho spawn between 16 and 19 kms upstream on Hyland Creek, 18 and 25 kms on Mahood, Bear, Fleetwood, and Guibble Creeks, 23 and 26 kms on Latimer Creek, and in the mainstem between 23 and 26 km upstream.

Rearing potential is questionable due to low summer flows, however the coho scale pattern reflects generally good freshwater growth and some estuary utilization by this stock.

ENHANCEMENT OPPORTUNITIES

A management study conducted in 1977 - 1978 by the Agricultural Resource Development Association, the Fish and Wildlife Branch, and the DFO Habitat Protection Division was to have included recommendations for enhancement for the Serpentine River. A report has yet to be issued.

Coho spawning area in Mahood Creek

The upper reaches of the Serpentine mainstem.

Table 1. Mean salmon escapements to Serpentine River, 1962 to 1978.

Year	Coho
1962-1966	510
1967-1971	945
1972-1976	2260
1977[1]	3000 (2400)
1978[1]	4500 (1800)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Serpentine River, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Late October	Late November	Late December
	1977	Early November	Mid December	Early January
	1978	Mid October	Early December	Early February

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Serpentine River System coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
43	Male	494	4	4.2	453	16	10.5
	Female	450	1	1.1	471	16	10.5
32	Male	454	56	58.9	443	67	44.1
	Female	484	32	33.7	487	51	33.6
22	Male	260	2	2.1	269	2	1.3
Combined	Male	447	90	63.4	441	136	55.5
	Female	481	52	36.6	482	109	44.5

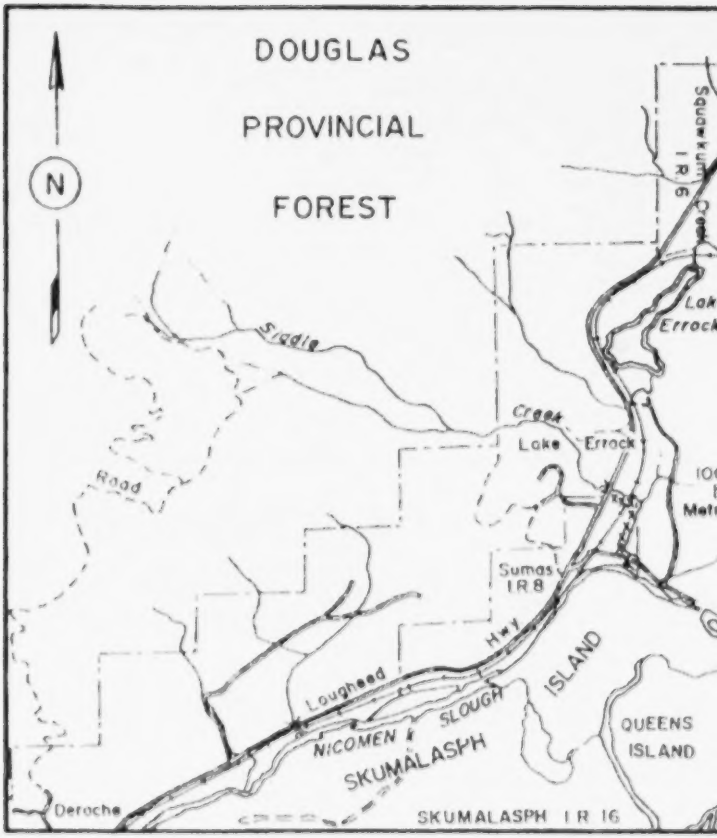
Table 4(a). Monthly mean daily discharges in m^3/sec for Serpentine River, metered near Port Kells (Station No. 08MH060).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1966	-	0.5	0.5	0.2	0.1	0.1	0.1	0.1	0.1	-	-	--	--	
1963	0.6	0.9	0.6	0.6	0.2	0.1	-	-	-	-	-	--	--	--
1962	0.8	0.5	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.3	1.0	1.1	2.9(01/02)	0.1(01/22)
1961	-	-	-	-	0.4	0.1e	0.1	0.1e	0.1e	0.4	0.6	1.1	--	0(08/01)

e = estimated

Table 4(b). Monthly mean daily discharges in m^3/sec for Serpentine River, metered near Port Kells (Station No. 08MH060).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1974	3.0	2.9	2.1	1.4	1.0	0.4	0.1	0.1	0.1	0.2	1.2	2.7	16.4(02/02)	0.1(11/08)
1972	2.7	2.8	2.4	1.0	0.2	0.1	0.6	0.1	0.2	0.2	1.0	3.5	14.3(01/20)	0.1(07/06)
1971	3.0	2.2	2.5	0.8	0.1	0.1	0.1	0.1	0.2	0.7	3.1	2.1	14.9(01/26)	0.1(09/14)
1970	1.9	1.1	0.7	1.3	0.2	0.1	0.1	0.1	0.1	0.2	1.0	2.5	13.4(12/06)	0.1(07/28)
1969	2.1	2.1	1.7	1.9	0.3	0.1	0.1	0.1	0.5	0.9	1.4	1.7	19.2(01/04)	0.1(08/10)


DOUGLAS
PROVINCIAL
FOREST
N
Sradle
Road
Creek
Lake
Errock
Sumas
IR8
Hwy
Loughead
NICOMEN &
SLOUGH
SKUMALASPH
ISLAND
QUEENS
ISLAND
Deroche
SKUMALASPH I R 16

Harrison
Harrison Bay
KENT
DIST. MUN.
Harrison River
C P R
HARRISON
HILL
500 0 1000 2000
RIVER
CHILLIWACK
DIST. MUN
FRASER

SIDDLE (BELLS, TATHAM) CREEK

LOCATION

Flows in a southerly direction for approximately 6 km entering Nicomen Slough east of Deroche.

STREAM TYPE

Siddle Creek arises north of Nicomen Slough and drains a small watershed of approximately 6 km^2. The creek is steep in the upper 4 kms, changing in the lower 1.3 km to a riffle/pool form with excellent gravel deposits. Beaver dams are frequent throughout much of the lower creek. The lower 1 km has been cleared for farming, however a dense growth of trailing blackberry and alder now protects most of the creek. A small channel branches from the main creek near the railroad crossing and flows in a densely overgrown channel through farm fields before rejoining the mainstem approximately 250 m upstream from Nicomen Slough.

OBSTRUCTIONS

None were observed during 1977 or 1978, however beaver activity has caused delays during the spawning period.

WATERSHED UTILIZATION

The Siddle Creek drainage is primarily agricultural in the lowland area, with scattered residential development through the upper watershed. The CPR has diked and annually removes accumulated gravel from a 100 m section of the creek immediately above the railroad crossing.

FISHERIES RESOURCE

Siddle Creek coho spawn between kms 0.3 and 1.3 of the mainstem, and lightly throughout the west branch. Chum spawning has been reported in the lower 300 m, however, none was observed during this survey.

Rearing potential is good in the lower 1 km where there are undercut banks, beaver ponds, and isolated pools protected by overhanging growth.

ENHANCEMENT OPPORTUNITIES

Although high quality rearing habitat exists in Siddle Creek, it is very limited in extent. Opportunities to improve the rearing habitat in a 200 m section of both branches immediately below the CPR crossing through pool creation and the provision of cover should be investigated. Access to the west branch can also be substantially improved.

Based on an assessment of available rearing habitat, Nicomen Slough appears to be the primary nursery area for the Siddle Creek coho stock. Although Siddle Creek is a small stream, sufficient surface water is available for an incubation box which can be used to exploit the potentially underutilized rearing habitat in Nicomen Slough.

Coho spawning area in Siddle Creek.

Siddle Creek near the confluence with Nicomen Slough.

Table 1. Mean salmon escapements to Siddle Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	230	60
1967-1971	460	25
1972-1976	570	35
1977[1]	1500	0 (25)
1978[1]	400 (200)	0 (25)

1. Bracketed figures are fishery officer escapement estimates.

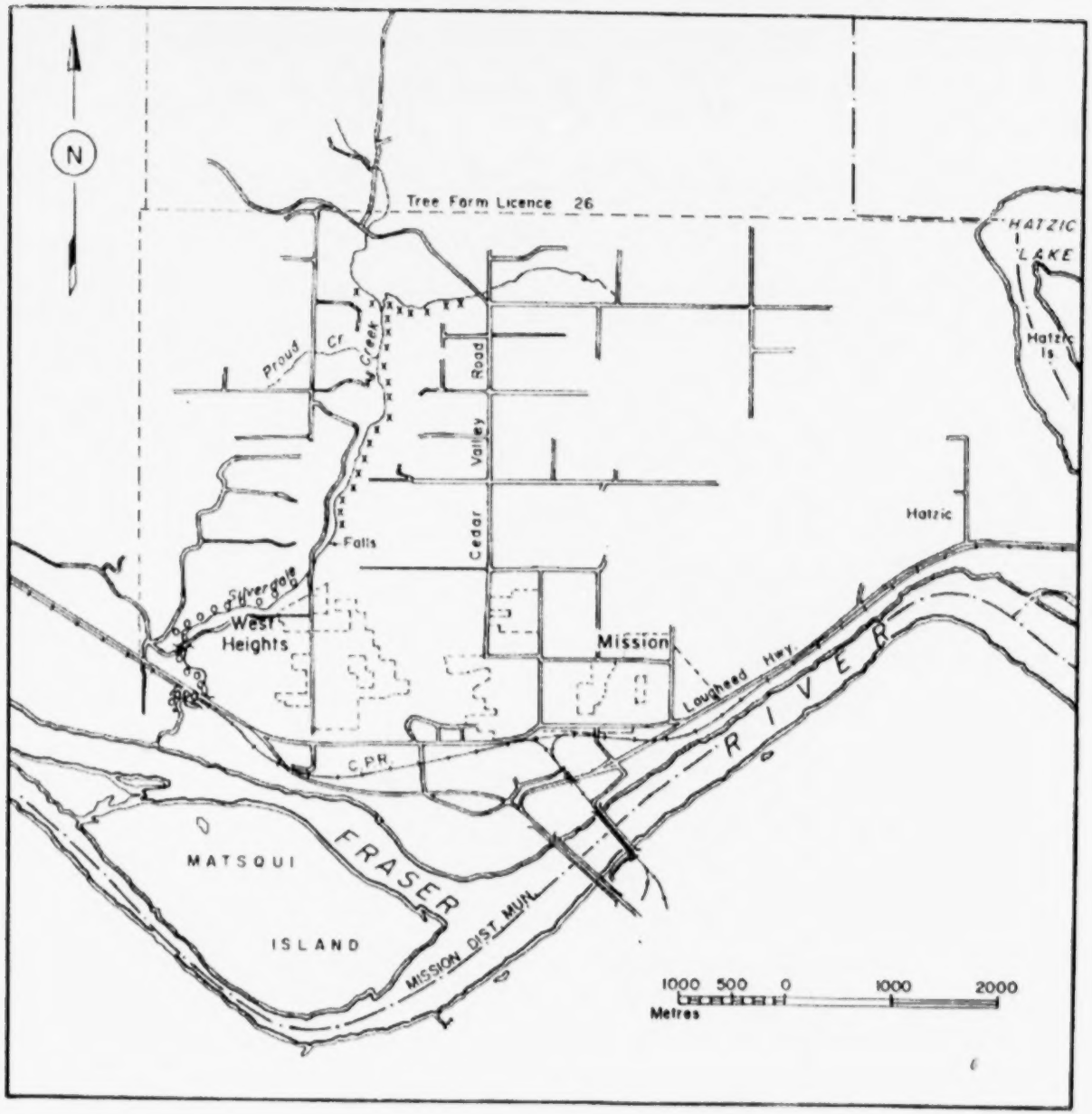
Table 2. Timing of salmon spawning in Siddle Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	November	December	January
	1977	Early November	Mid Dec/Late Jan[1]	Mid February
	1978	Mid November	Late December	Late February
Chum	1970-1976	November	December	December

1. Two distinct peaks.

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Siddle Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Male	465	1	0.9	478	2	2.7
	Female	535	1	0.9	457	2	2.7
3_2	Male	493	56	51.9	464	27	36.5
	Female	500	48	44.4	470	43	58.1
2_2	Male	303	2	1.8	-	0	-
Combined	Male	482	71	56.8	462	41	41.0
	Female	497	54	43.2	468	59	59.0


N
Tree Farm Licence 26
HATZIC LAKE
Hatzic Is.
Proud Cr
Creek
Road
Valley
Cedar
Falls
Hatzic
Silvergate
West Heights
Mission
Lougheed Hwy
RIVER
C.P.R.
FRASER
MATSQUI
ISLAND
MISSION DIST. MUN.
1000 500 0 1000 2000
Metres

SILVERDALE CREEK

LOCATION

Flows south for approximately 8 km entering Fraser River at the west end of Matsqui Island.

STREAM TYPE

Silverdale Creek drains a watershed of approximately 22 km^2. Except for the lower 1 km, where the land has been cleared, the creek flows in a small, densely wooded valley. In the lower 1 km, the creek is slough-like, above which the stream-type is riffle/pool with a gradually increasing gradient and excellent gravel deposits. Between 3.1 km and a small falls at km 4.3, the stream is turbulent with a boulder substrate. A riffle/pool stream-type dominates over the next 1.5 km, and the creek forks 5.8 km upstream.

The west fork is small and turbulent, originating at a marshy lake at 8.0 km. The east fork flows for 2.7 km in a series of shallow pools and side channels which are protected by thickly overgrown shrubs and logs. Excellent gravel deposits exist in the lower 300 m.

OBSTRUCTIONS

A small rockfalls located approximately 4.3 km upstream impedes fish passage at certain discharges.

WATERSHED UTILIZATION

From 1913 until the 1940's, Mission City maintained a dam and water reservoir 4.5 km upstream. For the last 10 years, Mission Municipality has conducted a limited logging program in the headwaters of the east branch. Farming is restricted to the lower 1.3 km, and several licences to draw water for irrigation are in effect.

Commercial developments include Sun Valley Trout Farms (1968) on Silverdale Road and a gravel pit (Cannon Contracting) above Dewdney Trunk Road which has intermittently caused siltation in the creek. A trailer park above Dewdney Trunk Road discharges storm sewers into the west branch, and the Westbank Subdivision, located above the gulley to the east between 2 km and 4 km upstream, discharges storm sewer runoff into the creek at Tyler Road.

FISHERIES RESOURCE

Chum spawn heavily from 1.0 km upstream to 2.0 km and lightly up to 3.1 km, where cobble becomes more predominant.

Coho spawning is scattered from 1.5 km to 3.1 km, and is more concentrated in the upper area between 4.3 km and 5.8 km and in the lower 300 m of the east fork.

Rearing potential is good in the scattered, well protected pools of the middle and upper reaches.

ENHANCEMENT OPPORTUNITIES

Bank excavation and stabilization, debris removal, and gravel introduction is recommended in the east branch of Silverdale Creek in order to improve the coho spawning and rearing habitat in that area. A similar expansion of the chum spawning habitat below Silverdale Road may be appropriate. Sufficient surface water is available in this area for a chum incubation box.

The headwaters of Silverdale Creek have been logged in recent years.

This rockfall was modified to improve access for coho spawners.

Table 1. Mean salmon escapements to Silverdale Creek, 1962 to 1978.

Year	Coho	Chum	Pink (odd year)
1962-1966	55	80	1125
1967-1971	45	220	633
1972-1976	50[1]	280	650
1977	25	25	(50)
1978[2]	25	250 (2(100)	-

1. Bracketed figures are the fishery officer estimates.

Table 2. Timing of salmon spawning in Silverdale Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	October	December	February
	1977	Early November	Early December	Mid January
	1978	Late October	Early December	Early January
Chum	1970-1976	October	November	December
	1977	Mid October	Early November	Late December
	1978	Late September	Mid October	Late November
Pink	1970-1976	October	October	November

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Silverdale Creek coho salmon.

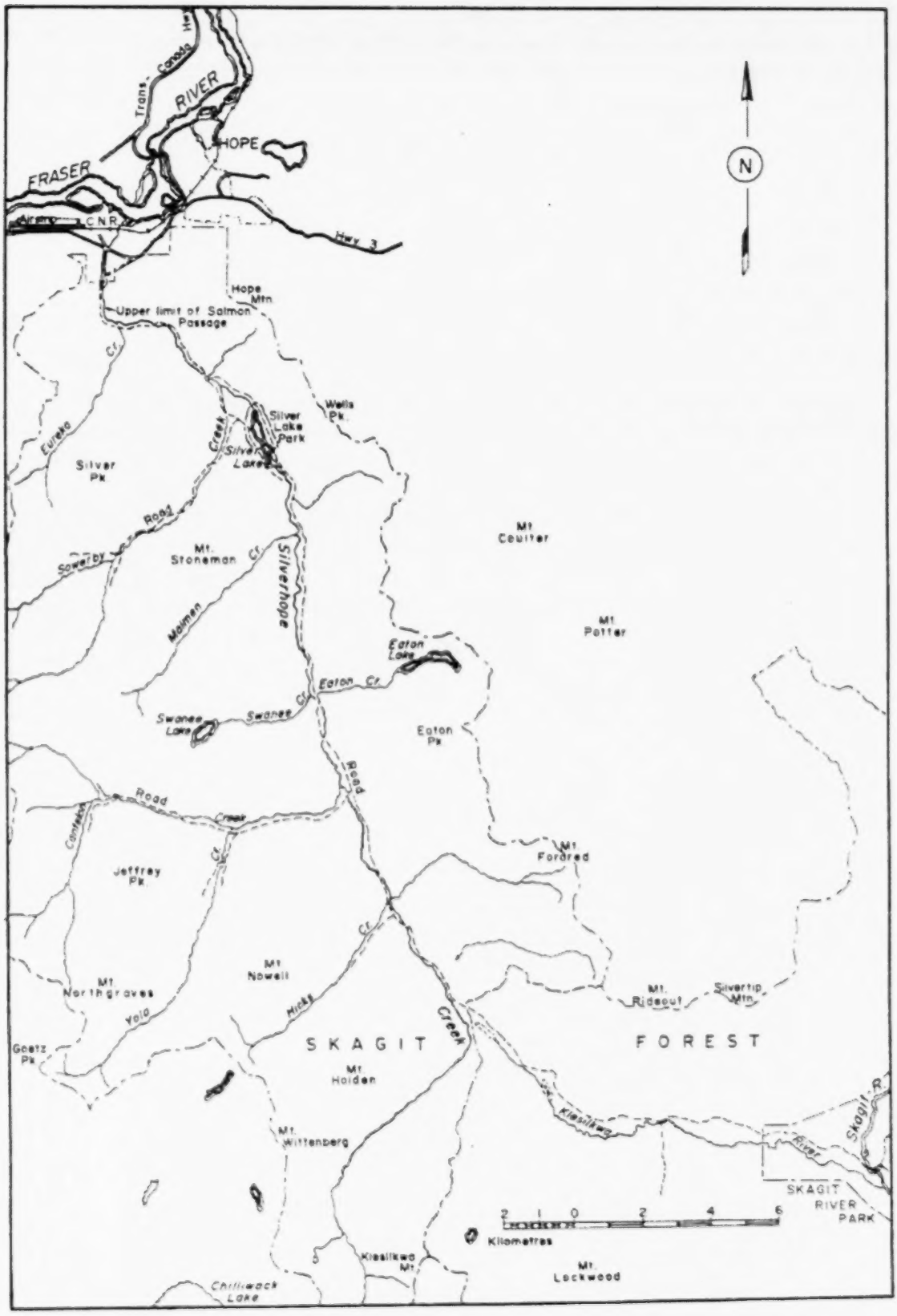
Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean length ((mm)	N	%
4_3	Male	435	1	2.6	--	0	--
	Female	-	0	-	418	1	2.1
2_2	Male	456	18	47.4	433	31	64.6
	Female	482	19	50.0	487	16	33.3
2_2	Male	-	0	-	--	0	--
Combined	Male	453	23	46.9	433	57	67.9
	Female	481	26	53.1	480	29	32.1

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Silverdale Creek chum Salmon.

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
5	Male	-	0	-	596	2	3.3
	Female	-	0	-	609	3	5.0
4	Male	574	16	34.8	574	19	31.7
	Female	563	28	60.9	564	29	48.3
3	Male	540	1	2.2	528	5	8.3
	Female	523	1	2.2	535	2	3.3
Combined	Male	572	17	37.0	567	26	43.3
	Female	562	29	63.0	566	34	56.7

Table 4. Monthly mean daily discharges in m^3/sec for Silverdale Creek, metered at Tyler Road (Station No. 08MH091).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	2.3	1.5	1.2	1.2	0.6	0.6	0.3	0.4	0.5	0.4	0.6	1.2	8.7(01/15)	0.2(08/12)
1975	1.6	1.1	1.3	0.7	0.7	0.3	0.2	0.4	0.3	1.2	1.8	3.1	15.1(12.02)	0.1(07/22)
1974	-	-	1.6	1.1	1.0	0.6	0.3	0.2	0.1	0.1	0.7	1.5	—	0.1(09/25)
1973	1.1	0.7	0.8	0.4	0.3	0.2	0.1	0.1	0.1	0.3	1.3	1.7	6.8(11/28)	0.1(09/12)
1972	1.7	2.4	2.5	1.3	0.7	0.4	0.9	0.2	0.4	0.2	0.7	2.6	10.1(12/26)	0.2(09/04)


Trans-Canada Hwy
FRASER
RIVER
HOPE
C N R
Hwy 3
N
Hope Mtn
Upper limit of Salmon Passage
Eureka Cr.
Silver Pk
Silver Creek
Silver Lake Park
Silver Lake
Wells Pk
Sowerby Road
Mt. Stoneman
Silverthrone Cr.
Mt. Coulter
Mt. Potter
Eaton Lake
Eaton Cr.
Swanee Lake
Swanee Cr.
Eaton Pk
Jeffrey Creek Road
Jeffrey Pk
Mt. Fordred
Mt. Northgraves
Mt. Nowell
Hicks Creek
Mt. Ridout
Silvertip Mtn.
SKAGIT
FOREST
Goetz Pk
Mt. Holden
Klesilkwa River
Skagit R.
Mt. Wittenberg
SKAGIT RIVER PARK
2 1 0 2 4 6
Kilometres
Klesilkwa Mt.
Mt. Lockwood
Chilliwack Lake

SILVERHOPE CREEK

LOCATION

Flows northwest for approximately 42 km entering Fraser River west of Hope.

STREAM TYPE

Silverhope Creek drains a mountainous watershed of 328 km^2. Arising at an altitude of 1370 m, the upper river drops 800 m in 8 km onto a broad, gently sloping, steep sided valley. Part of the flow drains southwest into Klesilkwa River, a tributary of Skagit River. The remainder meanders northwest for 21.5 km before entering Silver Lake (0.4 km^2 surface area). Below Silver Lake, the creek is a series of rapids and falls as it cascades through a narrow valley. At km 3.0 the slope decreases, and the lower creek is characterized by a boulder - rubble substrate with scattered gravel deposits.

OBSTRUCTIONS

Beginning 3 km upstream, a series of small falls, chutes and rapids impede fish passage. Blasting work undertaken in 1962 on a major falls located 3 km upstream has not substantially improved access. At present, this section is passable only to steelhead trout.

WATERSHED UTILIZATION

Although scattered residential development occurs along the lower creek, the primary activity in this watershed has been logging. Whonnock Lumber has filed plans to log Eureka, Hicks, and Sawerby Creek valleys and portions of the lower and upper mainstem.

Between 1932 and 1937, the Fisheries Department stocked Silver Lake with Kamloops trout. A tract of land immediately above Silver Lake was recently acquired by the Second Century Fund, and in 1979 the Fish and Wildlife Branch began stocking the upper river with steelhead trout fry transferred from the Fraser Valley hatchery.

FISHERIES RESOURCE

All Silverhope Creek salmon stocks spawn in the lower 3 km. Coho spawn throughout the lower river, chums spawn in a 2 km section below the falls, and pink spawning is concentrated between kms 0.5 and 1.1. Steelhead trout are the only anadromous species which spawn in the 21.5 km section of excellent gravel above Silver Lake.

Rearing potential is poor below Silver Lake due to the turbulent, exposed nature of the stream. Rearing potential above Silver Lake appears excellent. Fish and Wildlife Branch personnel assessed the productivity of this area as part of their headwater stocking program (Griffith 1979).

ENHANCEMENT OPPORTUNITIES

The primary production limiting factor in Silverhope Creek is the series of rapids, debris jams and chutes which prevent coho and chum access into the upper system. The most promising enhancement opportunity is the stocking of coho fry into the upper system in conjunction with stream work to alleviate access problems. However, any stocking should be conducted in conjunction with the Fish and Wildlife Branch program.

A former side channel with a flow control structure enters the mainstem immediately above the Highway 1 crossing. In view of the limited available chum habitat the feasibility of reopening this channel should be investigated.

Over 21 kms of presently unutilized salmon habitat exists above Silver Lake.

Rapids which are typical of the turbulent stream-type below Silver Lake.

Table 1. Mean salmon escapements to Silverhope Creek, 1962 to 1978.

Year	Coho	Chum	Pink (odd year)
1962-1966	55	80	1125
1967-1971	45	220	633
1972-1976	50[1]	280	650
1977	25	25	(50)
1978[2]	25	250 (100)	-

1. Observed 3 years only
2. Bracketed figures are the fishery officer estimates.

Table 2. Timing of salmon spawning in Silverhope Creek, 1970 to 1978.

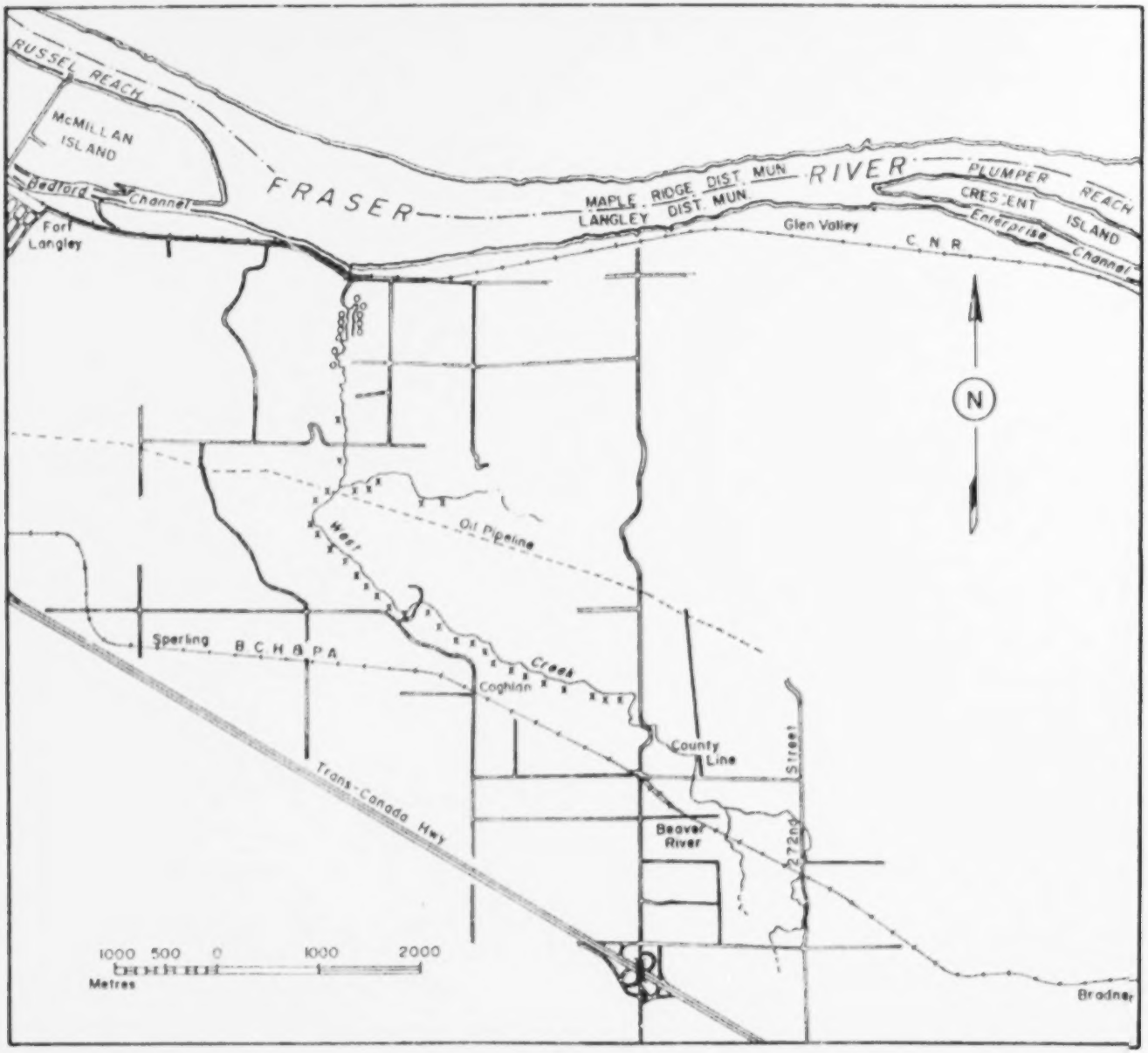
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Mid October	Early November	Mid December
	1977	Mid October	Early November	Mid December
Chum	1970-1976	Early September	Mid September	Mid October
	1977	Early September	October	December
	1978	Mid September	Early October	Late December
Pink	1970-1976	Mid September	Early October	Late October

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1978 Silverhope Creek chum salmon.

Age	Sex	1978		
		Mean Length(mm)	N	%
5	Male	-	0	-
	Female	624	2	6.5
4	Male	597	13	41.9
	Female	574	16	51.6
3	Male	-	0	-
	Female	-	0	-
Combined	Male	594	14	43.75
	Female	579	18	56.25

Table 4. Monthly mean daily discharges in m^3/sec for Silverhope Creek, metered near the Hwy. #1 crossing (Station No. 08MF009).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge	
													Max	Min
1971	10.7	21.7	7.9	13.6	35.4	30.9	28.6	8.4	5.2	14.6	14.1	6.8	51.5(05/12)	3.4(01/14)
1970	5.8	8.5	6.7	10.1	19.9	25.3	7.7	3.3	4.6	5.1	7.7	5.8	48.7(06/03)	2.3(09/02)
1969	5.2	2.8	5.1	17.6	37.7	28.0	11.0	4.3	7.5	8.4	11.2	8.5	46.2(05/09)	2.0(02/27)
1968	32.5	17.0	12.6	10.0	24.6	31.4	17.0	5.9	3.9	11.5	12.6	10.8	128.9(01/20)	2.6(09/28)
1967	17.3	14.2	5.5	7.6	34.3	57.2	23.3	7.4	4.6	31.2	33.7	25.1	208.2(10/31)	3.5(09/24)


RUSSEL REACH
McMILLAN ISLAND
Bedford Channel
FRASER
MAPLE RIDGE DIST. MUN
LANGLEY DIST. MUN
RIVER
PLUMPER REACH
CRESCENT ISLAND
Enterprise Channel
Fort Langley
Glen Valley
C N R
N
West
Oil Pipeline
Sperling
B C H B P A
Creek
Coghlan
County Line
Street
Trans-Canada Hwy
Beaver River
272nd
1000 500 0 1000 2000
Metres
Bradner

WEST CREEK

LOCATION

Flows in a westerly direction for approximately 6 km entering Fraser River east of McMillian Island.

STREAM TYPE

West Creek arises in a lowlying marshy area and drains a watershed of approximately 7.5 km^2. Between kms 4.6 and 2.5 the creek flows through a densely wooded gulley and has a rapids/pool form with scattered gravel deposits. At 2.5 km, the creek flows onto the Fraser River flood plain where it meanders through exposed farmland, becoming slough-like in the lower 200 m.

A small, 100 m long tributary joins the creek at approximately 0.4 km. This stream has excellent gravel deposits and is fed primarily by groundwater sources.

OBSTRUCTIONS

None were observed during 1977 or 1978.

WATERSHED UTILIZATION

The West Creek watershed is a low density agricultural/residential area. Two mink farms and a gravel pit are located in the lower 2.5 km. Much of the streamside cover has been removed from the lower 2.5 km causing extensive bank destabilization. Agricultural and domestic water withdrawal aggravates low summer flows. (Table 41).

FISHERIES RESOURCE

Coho spawning is scattered throughout West Creek, chum spawn in the tributary at 0.4 km, and in the lower 0.5 km of the mainstem.

Rearing in this stream is potentially good, with some isolated, protected pools and extensive instream debris. However, it is severly limited by minimum summer flows, which averaged only 0.071 m/sec in Jul/Aug over the last 5 years, and by the generally poor riffle to pool ratio.

ENHANCEMENT OPPORTUNITIES

Based on stream length and available habitat, West Creek appears to be underutilized by coho salmon. Although further study is necessary to determine the limiting factor, a low pool/riffle ratio in conjunction with low summer flows may be the primary cause. Pool creation throughout the creek may be an appropriate enhancement strategy.

Channel work similar to that described by Lister et al. (1980) is recommended for the lower tributary and the mainstem below 80th Avenue in order to expand and improve the chum spawning area.

Marshy area near the upper reaches of West Creek.

Stream type typical of the middle reaches of West Creek.

Table 1. Mean salmon escapements to West Creek, 1962 to 1978.

Year	Coho	Chum
1962-1966	95	131[1]
1967-1971	145	260
1972-1976	680	260
1977[2]	300 (750)	100 (200)
1978	200	125

1. Observed in 4 years only.
2. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in West Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Late November	Late December
	1977	Late October	Early December	Late January
	1978	Late October	Mid December	Mid January
Chum	1970-1976	Mid November	Mid December	Late December
	1977	Mid November	Mid December	Mid January
	1978	Early November	Late December	Mid January

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 West Creek coho salmon.

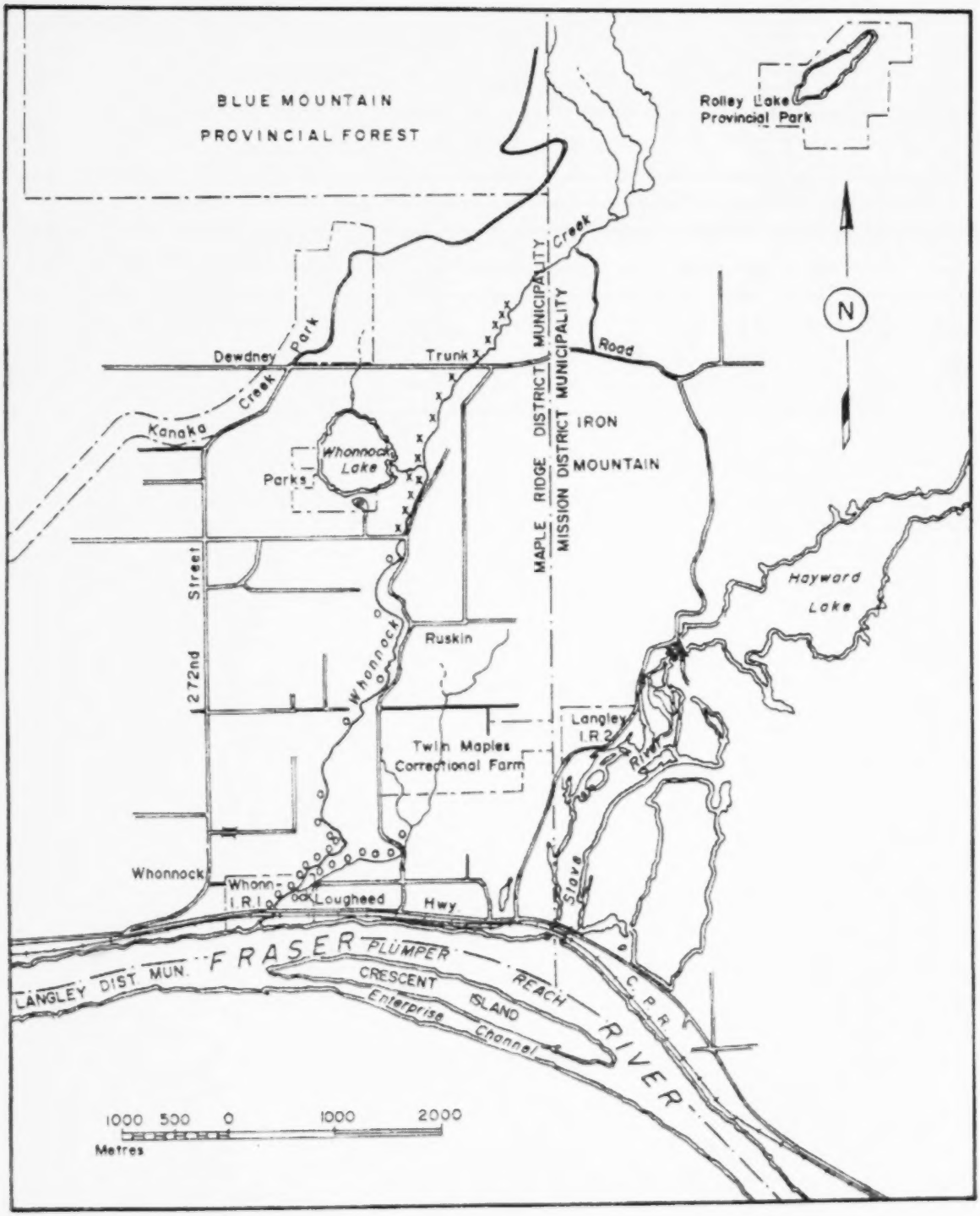
Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Male	-	0	-	--	0	--
	Female	490	1	1.3	--	0	--
3_2	Male	452	39	52.0	429	14	43.8
	Female	473	34	45.4	485	17	53.1
2_2	Male	251	1	1.3	263	1	3.1
Combined	Male	454	54	52.4	406	31	47.0
	Female	476	49	47.6	481	35	53.0

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1978 West Creek chum salmon.

Age	Sex	1978		
		Mean Length(mm)	N	%
5	Male	-	0	-
	Female	-	0	-
4	Male	600	13	18.8
	Female	580	37	53.6
3	Male	530	2	2.9
	Female	544	17	24.6
Combined	Male	590	15	21.1
	Female	568	56	78.9

Table 4. Monthly mean daily discharges in m^3/sec for West Creek, metered above 80th Avenue (Station No. 08MH098).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1976	1.1	0.8	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.5	4.5(01/15)	0.04(07/14)
1975	1.1	0.7	0.6	0.2	0.1	0.1	0.1	0.1	0.1	0.8	0.1	1.2	10.1(12/01)	0.02(07/22)
1974	1.2	1.3	0.8	0.4	0.3	0.1	0.1	0.1	0.1	0.1	0.3	1.1	11.0(02/03)	0.03(09/07)
1973	0.1	0.5	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0	1.3	7.3(11/28)	0.03(08/03)
1972	1.2	1.5	1.2	0.7	0.2	0.1	0.4	0.1	0.1	0.1	0.1	0.4	6.8(12/26)	0.02(08/13)


BLUE MOUNTAIN
PROVINCIAL FOREST
Rolley Lake
Provincial Park
N
Dewdney Trunk Road
Kanaka Creek
Whonnock Lake
Parks
MAPLE RIDGE DISTRICT MUNICIPALITY
MISSION DISTRICT MUNICIPALITY
IRON MOUNTAIN
Hayward Lake
272nd Street
Whonnock Creek
Ruskin
Twin Maples Correctional Farm
Langley I.R. 2
Slave River
Whonnock
Whonn. I.R. 1
Lougheed Hwy
LANGLEY DIST MUN.
FRASER
PLUMPER
REACH
CRESCENT ISLAND
Enterprise Channel
RIVER
C.P.R.
1000 500 0 1000 2000
Metres

WHONOCK CREEK

LOCATION

Flows south for approximately 12 km entering Fraser River at the west end of Crescent Island.

STREAM TYPE

Whonock Creek and its two small tributaries drain a watershed of approximately 19 km^2. The creek flows off the mountains onto a broad plateau before flowing down a narrow valley to the Fraser River. The lower 1.5 km section is riffle/pool with a gravel substrate, above which rapids predominate. Between kms 4.8 and 8.0 the stream meanders across the plateau, and a broad marsh is located at the mouth of the Whonock Lake tributary, approximately 5.0 km upstream. Above this section the slope increases sharply and the creek is impassable.

Whonock Creek is joined by two tributaries. A small tributary which enters at 1.2 km has gravel deposits in the lower 1 km. A tributary joining the mainstream at km 5.0 drains Whonock Lake, a shallow lake which may provide important coho rearing habitat.

OBSTRUCTIONS

None were observed during 1977 and 1978.

WATERSHED UTILIZATION

The Whonock Creek watershed is a low density residential/agricultrual are with little development along the creek.

FISHERIES RESOURCE

Whonock Creek chum spawning is heavy in the lower 1.3 km, and scattered up to km 5.0 and in the lower tributary. Coho spawn between kms 4.9 and 7.2.

Rearing potential is good, especially in the marshy area near km 5.0.

ENHANCEMENT OPPORTUNITIES

Whonock Creek is a small stream which has not been extensively disturbed by streamside developments. Based on an assessment of stream length and available rearing habitat, the stream appears to be underutilized by coho salmon, however identification of the production limiting factors requires further study.

Coho spawning habitat near Dewdney Trunk Road.

Excellent chum spawning and coho rearing habitat in the lower reaches of Whonock Creek.

Table 1. Mean salmon escapements to Whonock Creek, 1962 to 1978.

Year	Coho	Chum	Pink (odd year)
1962-1966	180	435	145
1967-1971	390	1130	117
1972-1976	240	1130	75
1977[1]	250 (600)	1000 (2200)	(50)
1978[1]	350 (200)	600 (750)	--

1. Bracketed figures are the fishery officer estimates.

Table 2. Timing of salmon spawning in Whonock Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Early December	Mid January
	1977	Early November	Mid December	Late January
	1978	Mid October	Early December	Mid January
Chum	1970-1976	Mid October	Mid November	Early December
	1977	Mid October	Late October	Late December
	1978	Late September	Late October	Mid December
Pink	1970-1976	Early October	Late October	Early November

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Whonock Creek coho salmon.

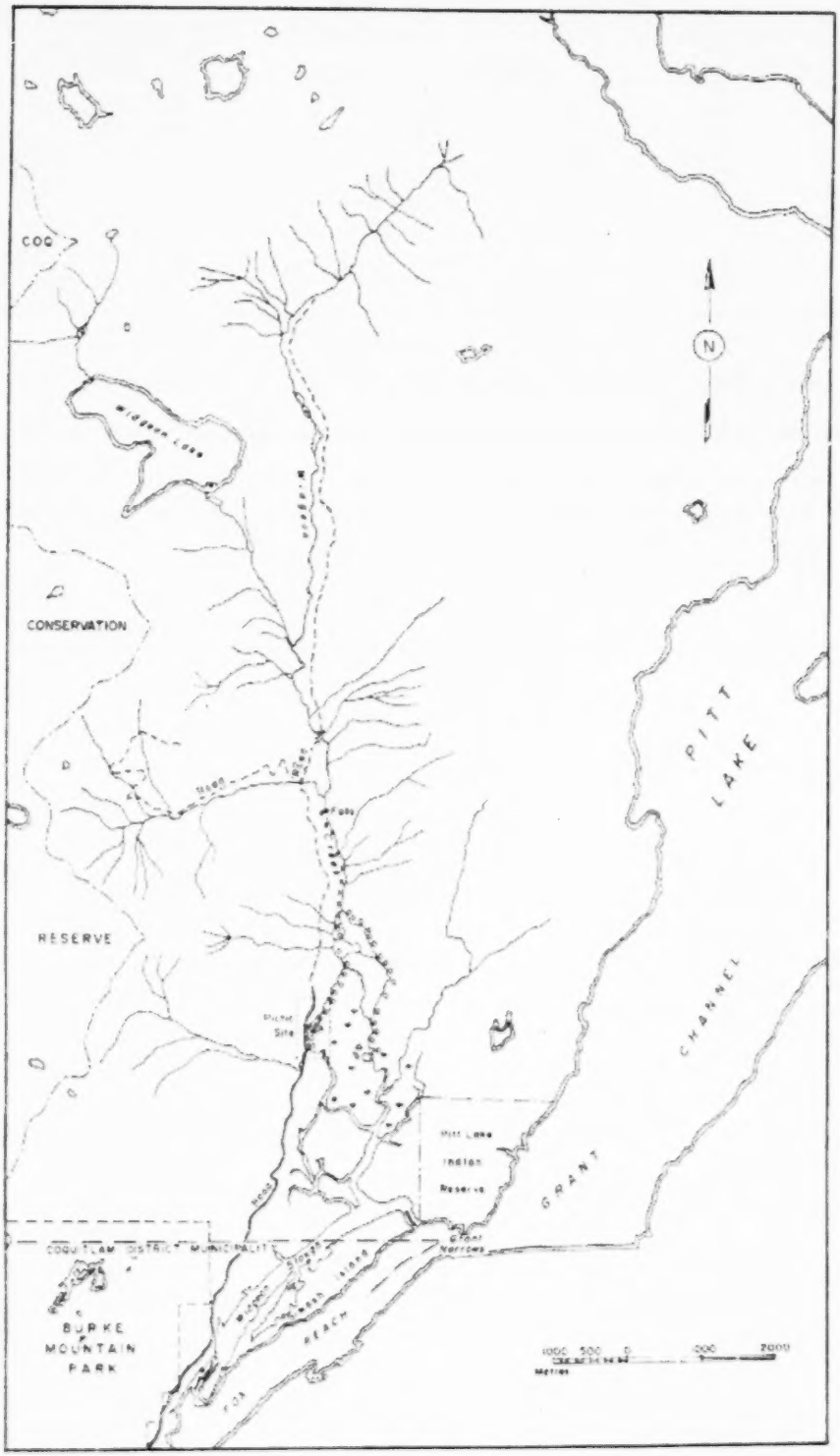
Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
43	Male	-	0	-	424	1	2.3
	Female	430	1	3.7	483	2	4.5
32	Male	431	18	29.6	435	18	40.9
	Female	477	18	66.7	468	21	47.7
22	Male	-	0	-	272	2	4.5
Combined	Male	460	13	31.0	410	34	54.0
	Female	477	29	69.0	473	29	46.0

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Whonock Creek chum Salmon.

Age	Sex	1977 Mean Length (mm)	1977 N	1977 %	1978 Mean Length ((mm)	1978 N	1978 %
5	Male	574	4	5.1	626	6	6.9
	Female	556	1	1.3	568	6	6.9
4	Male	593	29	37.2	575	20	23.0
	Female	566	44	56.4	563	44	50.6
3	Male	-	0	-	545	5	5.7
	Female	-	0	-	514	6	6.9
Combined	Male	591	33	42.3	582	33	33.0
	Female	566	45	57.7	558	67	67.0

Table 4. Monthly mean daily discharges in m^3/sec for Whonock Creek, metered at the Lougheed Highway crossing (Station No. 08MH099).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1964	-	1.0	1.6	0.9	0.9	0.7	-	-	-	-	-	-	-	
1963	1.0	2.1	0.7	0.7	0.2	0.2	0.6	0.4	0.2	0.6	1.8	—	-	-
1962	2.1	1.2	0.6	1.1	0.7	0.4	0.2	0.9	0.4	0.4	2.9	2.1	13.5(11/25)	.001(10/15)
1961	2.7	3.1	1.7	1.0	0.7	0.1	0.1	0.1	0.2	1.3	0.9	1.7	17.8(01/10)	0.02(08/09)
1960	-	-	-	1.3	1.3	0.6	0.1	0.3	0.5	1.4	1.6	1.2	5.0(12/12)	0.02(07/29)


COQ
CONSERVATION
RESERVE
PITT
LAKE
CHANNEL
GRANT
Pitt Lake
Indian
Reserve
Grant
Narrows
BURKE
MOUNTAIN
PARK
BEACH
N

WIDGEON CREEK

LOCATION

Flows south for approximately 16 km entering Widgeon Slough, a side channel of Pitt River, north of Port Coquitlam.

STREAM TYPE

The Widgeon Creek system, which includes Widgeon Lake and several tributaries, drains a watershed of approximately 80 km^2. The creek has a steep gradient and flows in a canyon for most of the upper 10.5 km. The valley broadens at 5.5 km and the creek flows across a wide alluvial fan. Widgeon Creek forks at km 4.0, with the west branch receiving most of the flow. The west branch is broad with a rapids/pool streamtype, while the east branch is narrow with a meandering riffle/pool form. Below km 2.0, both branches are marshy, with numerous side and cross-channels.

OBSTRUCTIONS

There is an impassable 9 m high rockfalls approxiamtely 6 km upstream.

WATERSHED UTILIZATION

The Widgeon Creek watershed has been logged intermittently since 1940. Logging prior to 1960 was reported to have disrupted flow patterns, however flows have stabilized since that time. B.C. Forest Service conducted a timber thinning program between 1975 and 1979 as part of a plan to harvest the secondary and remaining primary timber in the watershed.

The Widgeon Lake area is a popular recreational site and in 1972 BCFS developed a public campground 2 km upstream. In 1976 Environment Canada established a wildlife refuge on 160 acres of marshy land in the central lowland area.

FISHERIES RESOURCE

Coho spawn from 3.5 to 5.5 km in both branches. Chum spawn from 2.5 km to 4.0 km in west Widgeon, and 2.0 km to 3.0 km in east Widgeon Creek.

Sockeye spawn in Widgeon Slough from 1.5 km to 3.0 km upstream. Pink salmon have not been reported since 1957.

Rearing potential is good, especially in east Widgeon Creek. There is extensive instream debris in the middle sections, and the lower 2.5 km is characterized by cut banks, pools and side and back channels protected by overhanging vegetation. Rearing potential in the slough is questionable due to heavy siltation.

ENHANCEMENT OPPORTUNITIES

Access to Widgeon Creek is restricted to a private road. Sufficient surface water is available for an incubation box facility.

An impassable series of rockfalls located on the mainstem approximately 6 kms upstream.

Chum spawning habitat on the west branch of Widgeon Creek.

Table 1. Mean salmon escapements to Widgeon Creek, 1962 to 1978.

Year	Coho	Chum	Sockeye
1962-1966	830	370	620
1967-1971	650	500	813
1972-1976	370	430	937
1977	1500	3500	N/R
1978	900	750	N/R

1. Bracketed figures are the fishery officer estimates.

Table 2. Timing of salmon spawning in Widgeon Creek, 1970 to 1978.

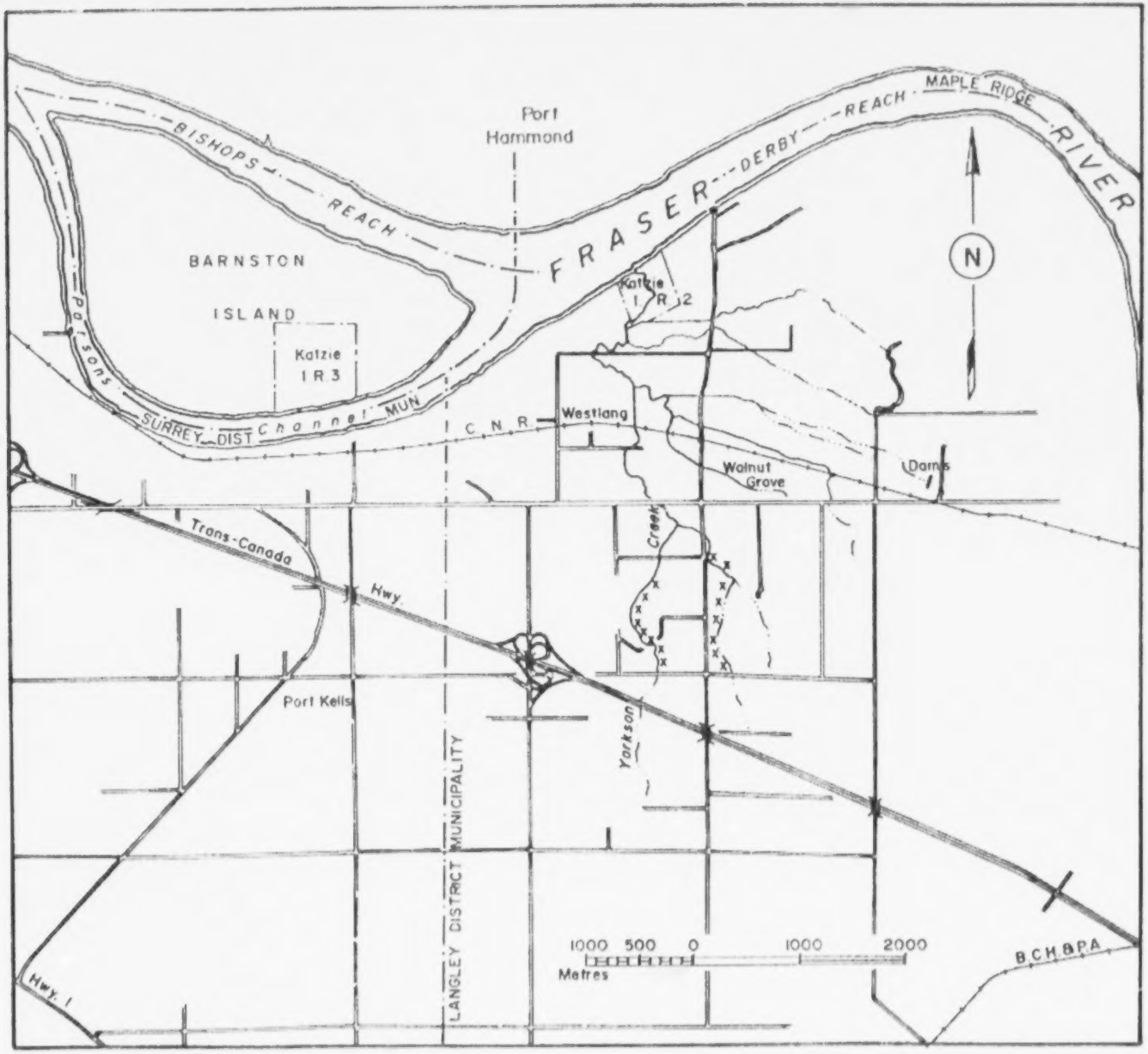
Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Late November	Mid December
	1977	Mid November	Early December	Early February
	1978	Early November	Mid December	Early February
Chum	1970-1976	Late October	Mid November	Late November
	1977	Mid October	Mid November	Early December
	1978	Late October	Early November	Mid December
Sockeye	1970-1976	Late September	Early October	Mid October

Table 3(a). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Widgeon Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Male	-	0	-	375	1	4.2
	Female	598	2	22.2	494	2	8.3
3_2	Male	498	5	55.6	414	6	25.0
	Female	465	2	22.2	522	9	37.5
2_2	Male	-	0	-	266	6	25.0
Combined	Male	484	6	60.0	388	20	60.6
	Female	531	4	40.0	513	13	39.4

Table 3(b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Widgeon Creek churn Salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
5	Male	645	1	1.1	—	0	--
	Female	-	0	-	606	4	3.4
4	Male	623	32	36.8	620	20	17.2
	Female	588	50	57.5	578	66	56.9
3	Male	603	3	3.5	559	4	3.4
	Female	585	1	1.1	542	22	19.0
Combined	Male	622	37	41.6	610	24	20.5
	Female	588	52	58.4	570	93	79.5


Port
Hammond
BISHOPS REACH
FRASER
DERBY REACH
MAPLE RIDGE
RIVER
BARNSTON
ISLAND
Katzie
I R 3
Katzie
I R 2
N
Parsons
SURREY DIST
Channel MUN
C N R
Westlang
Walnut
Grove
Dams
Trans-Canada
Hwy
Creek
Port Kells
Yorkson
LANGLEY DISTRICT MUNICIPALITY
1000 500 0 1000 2000
Metres
Hwy. 1
B C H & P A

YORKSON (JENKINS) CREEK

LOCATION

Flows north for approximately 7 km, entering the Derby Reach of Fraser River 1.5 km east of Barnston Island.

STREAM TYPE

Yorkson Creek is a small, low gradient stream which drains a watershed of approximately 18 km^2. The stream flows in a small, densely vegetated gulley for the upper 4 km before flowing across an area of low lying farmland. Three small tributaries join the creek in the lower 3 km, however only Munday Creek, which joins the mainstem 3.5 km upstream, is important to coho production.

OBSTRUCTIONS

All salmonid migrants must pass through a pumphouse facility located in the lower reaches of the creek.

WATERSHED UTILIZATION

The lowland area is primarily agricultural, with some industrial development. The upland area has scattered residential development, with subdivision construction occurring in the headwaters.

FISHERIES RESOURCE

Coho spawning is scattered from 4.0 km upstream to 4.8 km on the mainstem, and over the lower 1.3 km of Munday Creek.

There are some potentially good rearing areas, but these are limited in extent by extreme low flows and high summer water temperatures.

ENHANCEMENT OPPORTUNITIES

Yorkson Creek may benefit from gravel introduction above 93A Avenue, however low summer flows, habitat degradation from subdivision construction, and pumping activities limit potential production from this system.

A thickly overgrown section of Yorkson Creek. Scattered spawning occurs throughout this area.

The lower section of Yorkson Creek drains lowlying farmland.

Table 1. Mean salmon escapements to Yorkson Creek, 1962 to 1978.

Year	Coho
1962-1966	65
1967-1971	175
1972-1976	520
1977[1]	150 (350)
1978[1]	75 (150)

1. Bracketed figures are fishery officer escapement estimates.

Table 2. Timing of salmon spawning in Yorkson Creek, 1970 to 1978.

Species	Year	Spawning		
		Start	Peak	End
Coho	1970-1976	Early November	Late November	Late December
	1977	Early November	Mid December	Late January
	1978	Early November	Late December	Mid January

Table 3. Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Yorkson Creek coho salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length ((mm)	N	%
4_3	Male	-	0	-	--	0	--
	Female	460	2	6.25	--	0	--
3_2	Male	455	10	31.25	392	2	33.3
	Female	478	17	53.1	486	4	66.7
2_2	Male	300	3	9.4	--	0	--
Combined	Male	428	19	41.2	392	2	28.6
	Female	478	24	59.8	483	5	71.4

Table 4. Monthly mean daily discharges in m^3/sec for Yorkson Creek, metered at 96th Avenue (Station No. 08MH097).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Daily Discharge Max	Daily Discharge Min
1974	0.4	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	2.5(02/03)	0.01(08/05)
1973	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.4	2.1(12/15)	0.02(09/15)
1972	0.3	0.4	0.4	0.2	0.1		0.1	0.1	0.1	0.1	0.1	0.1	4.8(12/25)	0.01(12/15)
1971	0.5	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	3.5(01/26)	0.02(07/29)
1970	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	1.4(12/06)	0.02(06/07)

APPENDIX 2 - SUMMARY OF COHO BIOLOGICAL DATA

a) Summary of timing of coho spawning observed in the survey streams during 1977 and 1978.

b) Summary of coho salmon escapements to the survey streams, 1962 to 1978.

c) Summary of the age, mean postorbital-hypural plate length, and sex composition of 1977 coho salmon spawning ground recoveries.

d) Summary of the age, mean postorbital-hypural plate length, and sex composition of 1978 coho salmon spawning ground recoveries.

Appendix 2 (a). Summary of timing of coho spawning observed in the survey streams during 1977 and 1978.

Stream	Timing of Spawning: Start 1977	Start 1978	Peak 1977	Peak 1978	End 1977	End 1978
Alouette River	Early November	Late October	Early December	-	Early February	Early February
Big Silver Creek[1]	-	Late November	-	-	-	-
Campbell River	Late October	Late October	Mid November	Late November	Mid January	Mid January
Chilqua Creek	Early November	Mid November	-	Late December	Early January	Late January
Clayburn Creek	Early November	Late November	Late December	Late December	Mid February	Late February
Cohoe Creek	Early November	-	Early December	-	Late January	-
Dunville Creek	Mid November	Late January	Early February	Mid February	EarlyMarch	Mid March
Elk Creek	Mid November	Early February	Early February	Mid February	Early March	Late March
Hicks Creek	Early November	Early November	Mid February	Mid February	Early March	Early March
Kanaka Creek	Early November	Early November	Early December	-	Early January	Mid March
Kawkawa Creek	Mid November	Late October	Late November	Early December	Early January	Late December
Lagace Creek	Early November	Late October	Early December	-	Late December	Late December
Lorenzetta Creek	Early November	Early November	Late December	Early January	Early February	Early March
Luckakuck Creek	Mid November	Mid November	Late December	Late January	Early February	Late February
MacIntyre Creek	Late October	Late October	Late November	Mid November	Early February	Early February
Nathan Creek	Early November	Late October	Early December	Early December	Late January	Mid January
Nicomekl River	Late October	Late October	Mid November	Mid December	Late January	Late January
Nicomen Slough	Mid November	Early November	Early December	Mid December	Late January	Early January
-Deroche Creek	Mid November	Early November	Early December	Mid December	Late January	Early February
-Pye Creek	Mid November	Mid December	Mid December	Late Dec/Early Feb	Late January	Late February
-Barnes Creek	Mid November	Early November	Mid December	Mid December	Early February	Early March
Norrish Creek	Mid November	Late November	Late December	Mid January	Early February	Late February
Pitt River,Upper	Mid November	Mid November	Mid December	Late December	Late January	Early February
Salmon River	Late October	Early November	Mid December	Mid Dec/Mid Feb.	Early February	Late February
Serpentine River	Early November	Mid October	Mid December	Early December	Early January	Early February
Siddle Creek	Early November	Mid November	Mid Dec/Late Jan	Late December	Mid February	Late February
Silverdale Creek	Early November	Late October	Early December	Early December	Mid January	Early January
Silverhope Creek	Mid October	N/O	Early November	N/O	Mid December	N/O
West Creek	Late October	Late October	Early December	Mid December	Late January	Mid January
Whonock Creek	Early November	Mid October	Mid December	Early December	Late January	Mid January
Widgeon Creek	Mid November	Early November	Early December	Mid December	Early February	Early February
Yorkson Creek	Early November	Early November	Mid December	Late December	Late January	Mid January

1. Incomplete due to poor road access; survey crews were snowed out.

Appendix 2 (b). Summary of coho salmon escapements to the survey streams. Unless otherwise indicated, all 1977 and 1978 escapements are survey estimates; all five year averages are from escapement files.

Stream	Estimated Escapements				
	1962-1967	1968-1971	1972-1976	1977	1978
Alouette River, North	215	350	425	300	250
Alouette River, South	85	335	600	450	250
Big Silver Creek	25	200	125	-	(75)
Chilqua Creek	35	65	45	25	25
Clayburn Creek	150	187	488	600	800
Cohoe Creek	400	460	690	1,500	(1,500)
Dunville Creek	150	355	91	450	300
Elk Creek	355	500	275	600	650
Hicks Creek	1,580	1,200	695	600	950
Kanaka Creek	80	185	320	50	100
Kawkawa Creek	140	644	525	600	400
Lagace Creek	25	50	150	50	50
Lorenzetta Creek	190	292	155	75	150
Luckakuck Creek	90	38	90	100	250
Maria Slough	240	215	175	0	0
MacIntyre Creek	70	95	60	400	375
Nathan Creek	125	145	925	700	1,100
Nicomen Slough	680	240	295	1,500	500
Norrish Creek	350	580	320	150	400
Pitt River, Upper	2,800	7,900	3,000	7,500	17,500
Salmon River	150	1,095	2,570	3,500	5,500
Siddle Creek	230	460	570	1,500	400
Silverhope Creek	55	45	50	25	25
Silvervale Creek	300	295	220	200	300
West Creek	95	145	680	300	200
Whonock Creek	180	390	240	250	350
Widgeon Creek	830	650	370	1,500	900
Yorkson Creek	65	175	520	150	75
TOTAL	9,690	17,291	14,669	23,075	30,375
	Boundary Bay Tributaries				
Campbell River	390	420	4,404	500	1,500
Nicomekl River	1,600	1,135	2,900	3,500	600
Serpentine River	510	945	2,260	3,000	4,500
TOTAL	2,500	2,500	9,200	7,000	6,000

Appendix 2 (c). Summary of the age, mean postorbital-hypural plate length, and sex composition of 1977 coho salmon spawning ground recoveries.

Stream	Mean Postorbital-Hypural-Plate Length in mm (Sample size)/95% Confidence Limits AGE 2$_1$ Male	AGE 2$_1$ Female	AGE 3$_2$ Male	AGE 3$_2$ Female	AGE 3$_3$ Male	AGE 3$_3$ Female	AGE 2$_2$ Male	SEX Male	SEX Female
Alouette River	575(1) -	-	522(6) 433-611	513(8) 465-561	-	-	-	516(10) 469-567	508(12) 473-543
Campbell River	-	480(1)	513(14) 470-556	485(16) 440-490	-	-	-	505(17) 469-541	471(19) 447-493
Chilliwa Creek	-	-	407(1)	493(2) 417-569	-	-	313(2) 188-422	390(4) 294-546	493(2) 417-569
Clayburn Creek	-	555(1)	478(31) 458-498	489(40) 478-500	-	-	343(2)	465(36) 445-485	493(51) 483-503
Coho Creek	465(1)	485(2)	486(29) 466-506	492(23) 475-509	-	-	-	484(32) 466-502	489(30) 476-502
Doniville Creek	-	-	500(22) 481-519	499(25) 483-515	-	-	-	499(29) 484-514	496(29) 481-511
Elk Creek	430(2)	504(7) 486-521	489(34) 485-513	495(36) 476-494	-	-	294(10) 264-324	494(54) 429-479	486(36) 476-494
Hicks Creek	500(1)	461(4) 431-491	489(53) 476-502	499(52) 489-509	-	-	306(5) 278-338	474(64) 457-491	496(67) 487-505
Kanaka Creek	-	-	472(5) 449-495	500(1)	-	-	-	472(5) 449-495	500(1)
Kawkawa Creek	-	613(2)	432(5) 334-530	537(11) 497-577	405(2)	410(1)	286(5) 254-318	359(14) 311-407	539(14) 495-583
Lingrow Creek	-	-	425(2)	462(1)	-	-	-	425(2)	462(1)
Lorenzetto Creek	-	-	490(11) 459-521	474(3) 328-620	-	-	278(2) 158-436	464(14) 408-502	474(3) 328-620
Luckaluck Creek	-	405(1)	445(2)	486(6)	-	-	-	475(3) 337-613	474(7) 417-532
MacIntyre Creek	-	-	507(3) 394-620	494(5) 462-526	-	-	263(2) 251-315	409(10) 333-485	497(7) 469-525
Nahatlatch Creek	463(4) 416-513	478(7) 441-516	462(57) 448-476	481(53) 471-491	-	-	-	457(104) 441-467	477(83) 469-485
Nicomekl River	538(2)	475(1)	472(26) 443-501	499(19) 484-514	-	-	-	480(35) 456-504	499(25) 487-511
Nicomen tributaries --Deroche Creek	425(1)	-	495(116) 471-519	462(37) 443-481	-	-	268(3)	479(23) 457-503	480(44) 472-488
--Pye Creek	-	-	443(5) 343-543	-	-	-	-	443(5) 343-543	-
--Domes Creek	-	-	529(1)	495(1)	-	-	-	520(3) 498-542	495(1)
Nourish Creek	-	-	498(8) 473-523	507(13) 382-632	-	-	261(1)	460(11) 431-529	523(14) 440-606
Salmon River	489(9) 402-514	495(1)	474(86) 462-486	474(68) 465-483	-	-	300(10) 267-333	458(159) 448-468	475(110) 468-482
Serpentine River	494(4) 391-597	450(1)	484(36) 468-468	484(32) 470-498	-	-	260(2)	467(90) 454-480	481(52) 471-491
Siddle Creek	465(1)	535(1)	493(56) 479-507	500(48) 489-511	-	-	303(2) 271-335	482(71) 466-498	497(54) 487-508
Silverdale Creek	435(1)	-	456(18) 431-481	462(13) 446-478	-	-	-	453(23) 433-473	481(26) 465-497
West Creek	-	490(1)	452(39) 435-469	473(34) 464-482	-	-	251(1)	456(54) 439-473	476(49) 468-484
Whonock Creek	-	430(1)	431(18) 387-475	477(18) 436-476	-	-	-	460(13) 417-503	477(29) 462-492
Widgeon Creek	-	598(2)	478(5) 403-553	463(2)	-	-	-	484(6) 424-544	531(4) 396-666
Yorkson Creek	-	460(2)	465(10) 433-387	478(17) 466-490	-	-	300(3) 238-362	428(19) 389-467	478(24) 469-487
TOTAL	478(27) 445-495	498(35) 479-517	476(609) 472-481	487(380) 484-490	405(2) -	410(1) -	300(50) 288-312	462(930) 458-467	486(804) 483-489
Relative frequency (%)	2.1	2.7	46.7	44.5	0.2	0.1	3.8	53.7	46.9

Appendix 2 (d). Summary of the age, mean postorbital-hypural plate length, and sex composition of 1978 coho spawning ground recoveries.

Mean Postorbito-Hypural Length in mm (Sample size)/95% Confidence Limits

STREAM	AGE 4$_2$ MALE	AGE 4$_2$ FEMALE	AGE 3$_2$ MALE	AGE 3$_2$ FEMALE	AGE 3$_3$ MALE	AGE 3$_3$ FEMALE	AGE 2$_2$ MALE	SEX MALES	SEX FEMALES
Alouette River	-	-	482(3) 363-601	502(2) 500-516	-	-	285(3) 248-322	383(6) 265-502	534(3) 430-646
Campbell River	552(3) 503-602	469(6) 423-504	469(45) 447-483	492(46) 478-505	-	-	319(1)	463(71) 447-479	484(72) 473-496
Chilliwack Creek	-	454(1)	-	-	-	-	-	440(1)	436(4) 330-542
Clayburn Creek	434(1)	457(1)	426(22) 396-460	470(23) 457-483	-	-	309(1)	434(33) 419-448	463(39) 446-478
Dunville Creek	-	-	440(6) 354-525	463(23) 448-479	-	-	-	440(6) 354-525	467(23) 452-483
Elk Creek	-	-	464(19) 446-480	472(42) 464-480	-	-	307(3) 252-361	439(22) 411-468	472(61) 464-479
Hicks Creek	464(3) 278-651	513(3) 408-617	485(49) 473-496	488(76) 477-492	-	-	290(3) 269-311	476(62) 461-491	484(93) 476-491
Kanaka Creek	-	-	507(1)	512(2)	-	-	257(2)	344(4) 171-517	485(3) 321-649
Kawkawa Creek	463(2)	-	480(20) 453-506	526(43) 512-539	347(4) 321-373	-	307(5) 265-369	434(31) 402-466	524(45) 511-537
Laguna Creek	-	-	-	523(2)	-	-	-	557(1)	513(3)
Latimette Creek	-	492(1)	468(12) 428-509	487(13) 451-523	-	-	-	462(16) 432-492	486(21) 464-508
Luckakuck Creek	619(2) 566-673	432(2)	467(23) 452-481	461(46) 450-471	-	-	-	462(29) 447-477	467(52) 457-467
Morkhute Creek	359(1)	506(2)	395(8) 338-452	496(16) 471-521	-	-	225(2)	356(14) 315-397	490(22) 468-512
Nathan Creek	-	463(4) 446-482	462(58) 427-498	468(50) 439-496	-	-	278(5) 256-302	438(99) 424-451	470(99) 464-476
Nicomekl River	433(2)	490(5) 402-578	479(10) 386-573	470(12) 436-504	-	-	-	446(22) 409-487	477(20) 454-499
Nicomen Slough	439(1)	466(1)	479(1) 431-568	465(9) 418-491	-	-	298(3)	457(16) 424-489	460(15) 439-481
Omeachie Creek	-	455(4) 375-536	476(22) 444-508	485(39) 473-497	-	-	307(1)	458(32) 421-495	480(46) 470-491
Pitt River	-	-	467(18) 428-506	469(17) 452-486	-	-	-	462(10) 428-496	468(10) 457-479
Salmon Creek	-	-	463(14) 429-497	473(17) 451-494	-	-	339(5) 293-385	395(11) 375-415	475(16) 454-496
Serpick Creek	-	510(1)	485(15) 459-512	469(22) 453-486	-	-	298(1)	477(24) 460-507	470(30) 459-482
Scott Creek	-	-	463(3) 387-542	441(3) 345-537	-	-	-	452(6) 393-510	459(5) 413-505
Pitt River (Upper)	-	-	513(3) 470-556	521(8) 483-559	-	-	-	493(6) 467-520	516(9) 481-550
Salmon River	431(1)	531(3) 485-636	435(67) 423-448	473(46) 467-486	-	-	279(2) 235-324	429(107) 419-439	475(66) 469-482
Stoney Creek	-	486(3) 426-572	422(10) 359-456	484(42) 430-478	-	-	266(2) 178-395	413(33) 393-434	466(36) 455-477
Serpentine River	483(16) 420-550	477(16) 446-499	463(67) 429-457	469(55) 452-496	-	-	269(2) 229-314	441(136) 430-451	462(105) 453-490
Salmon Creek	439(7) 424-521	457(2) 334-782	464(27) 448-481	470(43) 459-482	-	-	-	462(41) 446-478	468(59) 459-477
Silverdale Creek	-	515(1)	433(3) 413-452	487(16) 468-505	-	-	-	453(57) 437-468	480(27) 464-496
West Creek	-	-	479(14) 456-502	484(17) 469-501	-	-	263(1)	438(31) 386-489	481(35) 470-491
Whonnock Creek	429(1)	483(2)	435(18) 417-461	468(21) 454-482	345(2)	-	272(2)	410(34) 387-434	473(29) 459-486
Widgeon Creek	376(1)	494(2)	414(6) 268-560	522(9) 499-545	-	-	286(6) 238-334	398(20) 339-457	513(12) 491-535
Yorkson Creek	-	-	392(2) 125-659	486(4) 461-512	-	-	-	392(2) 125-659	483(5) 466-503
TOTAL	455(36)	476(58)	452(593)	481(744)	346(6)	-	290(50)	439(904)	479(1,001)
	430-476	464-488	443-462	476-484	296-399		276-303	430-448	476-481
Relative frequency (%)	2.4	3.9	39.7	50.0	0.4	0	3.4	47.2	52.8

APPENDIX 3 - SUMMARY OF CHUM BIOLOGICAL DATA

a) Summary of timing of chum spawning observed in the survey streams during 1977 and 1978.

b) Summary of chum salmon escapements to the survey streams, 1962 to 1978.

c) Summary of the age, mean postorbital-hypural plate length, and sex composition of 1977 chum salmon spawning ground recoveries.

d) Summary of the age, mean postorbital-hypural plate length, and sex composition of 1978 chum salmon spawning ground recoveries.

e) Rates of travel of Fraser River chum stocks on their spawning migration.

Appendix 3 (a). Summary of timing of chum spawning observed in the survey streams during 1977 and 1978.

Stream	Timing of Spawning[1]					
	Start		Peak		End	
	1977	1978	1977	1978	1977	1978
EARLY TIMING						
Kowkowa Creek	Early October	Mid September	Mid October	Mid October	Early December	Early November
Silverhope Creek	Early September	Mid September	October	Early October	December	Late December
MIDDLE TIMING						
Alouette River,N.	Mid October	October	Mid November	Late October	Early December	Late November
Alouette River,S.	Mid October	Early October	Early November	Late October	Late December	Mid December
Big Silver Creek[2]	-	Mid October	-	Early November	-	Mid December
Chilliwack Creek	Early November	Early November	Mid November	Mid November	Early December	Late December
Hicks Creek	Early November	Late November	Late November	Late November	Late December	Early December
Kanaka Creek	Early October	Mid October	Mid October	Late October	Mid November	Mid December
Lagace Creek	Mid October	Early October	Early November	Late October	Late November	Late December
MacIntyre Creek	Mid October	Late October	Early November	Late October	Early December	Late November
Maria Slough	Early November	Early November	Late November	Late November	Late December	Late December
Silverdale Creek	Mid October	Late September	Early November	Mid October	Late December	Late November
Whonock Creek	Mid October	Late September	Late October	Late October	Late December	Mid December
Widgeon Creek	Mid October	Late October	Mid November	Early November	Early December	Mid December
LATE TIMING						
Campbell River	Mid November	Mid November	Early December	Mid December	Mid January	Mid January
Nicomen Slough	October	Late October	Late November	Early December	Early January	Early January
Norrish Creek, East	October	Mid October	Early December	Mid December	Late January	Late January
Norrish Creek, West	October	Late September	Mid December	Mid December	Mid January	Early January
Worth Creek	Mid November	Early December	Early December	Mid December	Early January	Early January
West Creek	Mid November	Early November	Mid December	Late December	Mid January	Mid January

1. Reconnaissance surveys commenced November 1, 1977. The timing of runs which began spawning prior to that date was from escapement files.
2. Big Silver Creek was not surveyed during 1977.

Appendix 3 (b). Summary of chum salmon escapements to survey streams. Unless otherwise noted, all 1977 and 1978 escapements are survey estimates; all five year averages are from escapement files.

Stream	Estimated Escapement				
	1962-1966	1967-1971	1972-1976	1977	1978
Alouette River, North[1]	360	365	1,265	5,000	300
Alouette River, South[1]	1,050	1,310	5,960	15,900	10,900
Big Silver Creek	55	83	70	(75)	200
Chilliqua Creek	25	475	385	2,000	1,000
Hicks Creek	30	35	25	250	25
Kanaka Creek	165	185	1,400	1,000	300
Kawkawa Creek	25	89	204	350	300
Lagace Creek[2]	326	220	378	400	400
Luckakuck Creek	25	54	23	0	0
Maria Slough	430	775	350	300	300
MacIntyre Creek	155	135	115	1,000	25
Nicomen Slough	1,550	980	2,510	5,000	6,000
Norrish Creek	135	1,930	2,550	3,500	6,500
Worth Creek	N/R	N/R	N/R	500	200
Siddle Creek	60	25	35	0	0
Silverhope Creek	80	220	280	25	250
Silverdale Creek	269	545	545	300	150
West Creek	131	260	260	100	125
Whonock Creek	435	1,130	1,130	1,000	600
Widgeon Creek	370	500	430	3,500	750
TOTAL	5,676	9,336	17,915	40,200	28,325
	Boundary Bay Tributaries				
Campbell River	45	90	290	200	50

Appendix 3 (c). Summary of the age, mean postorbital-hypural plate length, and sex composition of 1977 chum salmon spawning ground recoveries.

Stream	Mean Postorbital-Hypural Plate Length in mm (Sample size)/95% Confidence Limit							
	AGE 5		AGE 4		AGE 3		SEX	
	Male	Female	Male	Female	Male	Female	Male	Female
Alouette River, North	-	-	634(17) 613-654	584(13) 572-595	620(2) 550-690	-	627(25) 612-642	593(27) 584-602
Alouette River, South	628(1)	612(1)	626(8) 591-661	575(17) 557-592	586(7) 562-609	562(9) 541-583	607(17) 588-626	570(32) 558-582
Campbell River	-	-	588(2) 238-937	565(9) 544-586	574(12) 556-591	535(10) 518-551	576(14) 560-592	549(19) 535-563
Chilqua Creek	-	-	595(9) 564-627	575(7) 564-586	553(38) 543-563	538(33) 528-547	561(47) 551-571	544(40) 535-553
Hicks Creek	683(2) 651-715	-	642(6) 632-651	604(10) 588-620	600(4) 591-609	570(1) -	635(12) 615-655	601(11) 585-617
Kanaka Creek	-	-	583(12) 554-611	570(31) 560-581	547(1)	525(1)	580(13) 553-607	569(32) 558-580
Kawkawa Creek	610(1)	604(3) 551-566	596(11) 578-614	583(13) 566-600	551(2) 493-608	585(1)	591(14) 574-608	587(17) 573-601
Lagace Creek	-	-	571(8) 537-605	561(12) 522-599	557(3) 523-590	538(4) 496-580	567(11) 544-590	555(16) 525-585
MacIntyre Creek	620(1)	600(3) 510-690	601(37) 590-612	571(60) 564-578	540(1)	530(2)	600(39) 589-611	572(65) 565-579
Maria Slough	-	-	630(3) 585-675	613(2)	610(1)	570(3) 527-613	632(5)	587(5)
Nicomen Slough	625(1)	615(3) 578-652	604(29) 594-614	580(39) 573-587	533(6) 482-584	534(14) 521-547	593(36) 579-607	570(56) 562-578
Norrish Creek	617(4) 546-688	625(2) 498-752	611(37) 602-620	588(48) 578-598	562(22) 548-576	531(7) 518-544	595(63) 585-605	582(57) 572-592
Worth Creek	-	-	599(7) 583-614	574(3) 438-709	568(8) 552-583	544(5) 508-580	582(15) 569-595	551(8) 522-588
Silverdale Creek	-	-	574(16) 559-589	563(28) 554-573	540(1)	523(1)	572(17) 557-587	562(29) 552-572
Whonock Creek	574(4) 519-640	556(1)	593(29) 582-603	566(44) 559-572	-	-	591(33) 581-601	566(45) 560-572
Widgeon Creek	645(1)	-	623(32) 614-632	588(50) 579-597	603(3) 427-780	585(1)	622(37) 612-632	588(52) 580-594
TOTAL	619(15) 595-642	606(13) 590-621	604(263) 600-609	577(386) 574-580	563(111) 557-569	540(92) 534-546	594(396) 590-597	571(511) 569-574
Relative frequency (%)	1.7	1.5	29.9	43.9	12.6	10.5	43.8	56.2

Appendix 3 (d). Summary of the age, mean postorbital-hypural plate length, and sex composition of 1978 chum salmon spawning ground recoveries.

Stream	Mean Postorbital-Hypural Plate length in mm (Sample size)/95% Confidence Limits AGE 5 Male	AGE 5 Female	AGE 4 Male	AGE 4 Female	AGE 3 Male	AGE 3 Female	SEX Male	SEX Female
Alouette River, South	627(5) 590-664	589(4) 567-611	592(72) 583-600	568(71) 559-576	552(13) 537-567	537(14) 523-551	586(92) 577-594	564(91) 556-571
Big Silver Creek	702(1)	-	612(6) 598-626	580(13) 571-590	569(2)	538(6) 522-555	612(9) 581-643	567(19) 555-579
Campbell River	-	-	596(5) 562-631	554(6) 531-578	569(2)	533(8) 512-544	589(7) 560-617	542(14) 528-557
Chilqua Creek	-	-	580(59) 572-588	565(114) 560-570	552(3) 540-563	535(22) 519-551	579(63) 567-590	561(137) 556-566
Hicks Creek	-	579(1)	614(1)	580(10) 562-598	560(1)	-	605(3) 503-707	580(11) 564-596
Kanaka Creek	606(8) 589-623	592(3) 589-623	581(17) 567-595	565(28) 555-575	543(3) 518-568	539(6) 515-563	587(30) 575-599	563(37) 554-572
Kawkawa Creek	-	-	585(59) 579-591	567(39) 556-577	527(3) 462-592	527(3) 462-592	582(62) 575-589	566(44) 555-576
Lagace Creek	590(2) 216-965	612(2)	589(24) 571-608	576(37) 567-587	526(7) 490-561	528(14) 519-538	577(34) 560-593	565(53) 555-574
MacIntyre Creek	-	-	-	552(1)	-	518(2)	-	529(3) 463-595
Maria Slough	-	-	606(7) 568-644	576(11) 559-593	583(3) 552-615	570(1)	599(10) 573-625	570(13) 553-587
Nicomen Slough	659(2)	628(2)	598(244) 593-601	572(297) 569-575	558(88) 553-563	533(96) 527-537	587(345) 584-590	563(399) 559-565
Norrish Creek, East	581(2) 505-657	592(3) 562-622	598(99) 598-605	576(88) 570-581	551(29) 539-563	541(28) 530-552	587(134) 580-593	569(122) 563-574
Norrish Creek, West	637(10) 612-662	621(1)	596(88) 590-602	577(118) 572-531	554(6) 477-630	533(14) 517-549	597(108) 590-604	573(136) 568-578
Worth Creek	-	-	575(26) 566-585	576(15) 562-590	540(16) 524-556	547(5) 523-571	562(43) 553-572	569(20) 556-581
Silverdale Creek	596(2) 272-920	609(3) 554-665	574(19) 562-586	564(29) 555-573	528(5) 508-548	535(2)	567(26) 554-579	566(34 556-576
Silverhope Creek	-	624(2)	597(13) 575-620	574(16) 550-597	-	-	596(24) 575-617	579(18) 557-602
West Creek	-	-	600(13) 583-616	580(37) 572-588	530(2)	544(17) 528-561	590(15) 570-610	568(56) 560-577
Whonock Creek	626(6) 609-643	568(6) 528-609	575(20) 558-592	563(44) 555-570	545(5) 490-600	514(6) 478-55-	582(33) 567-597	558(67) 550-567
Widgeon Creek, East	-	607(2)	618(11) 602-634	582(32) 574-591	526(1)	540(13) 524-557	610(12) 588-632	572(47) 563-581
Widgeon Creek, West	-	604(2) 509-700	623(9) 604-642	574(34) 565-582	571(3) 502-640	544(9) 532-557	610(12) 588-631	569(46) 562-577
TOTAL	623(38) 612-634	597(31) 587-607	593(792) 591-595	572(1040) 570-573	552(192) 548-557	536(266) 532-539	586(1052) 584-588	565(1367) 564-567
Relative frequency (%)	1.6	1.3	33.6	44.1	8.1	11.3	43.5	56.5

Appendix 3 (e). Rates of travel of Fraser River chum stocks on their spawning migration.

Palmer (1972) summarized the migratory timing of Harrison, Vedder and Stave River chum salmon based on tagging studies conducted between 1960 and 1969. Pertinent data from these studies are summarized in Appendix Table i. Assuming the study stocks behave in a similar manner, these data can be used to estimate the pattern of migration of these stocks through the major fishery areas. However, the time out between Silverdale and dead recovery must first be divided into the respective migratory, holding, and spawning components.

Palmer estimated the rate of travel through the Fraser River mainstem at 15 miles/day below Silverdale and less than 5 miles/day between Silverdale and the major spawning areas. It is likely that the mainstem rate of travel remains constant and that a period of delay or holding occurs prior to movement onto the spawning grounds. Assuming a mainstem rate of travel of 13 miles/day, the average combined holding and spawning time for the major tributaries was calculated at 19.25 days for the early migrants and 21.95 days for the late migrants (Appendix Table ii). The study stock migratory peaks at Cottonwood Drift were predicted by using the above data to back date from the observed peak dead recovery in each study stream. Peaks at Johnstone Strait were based on a time okut between Cottonwood Drift and Johnstone Strait of 20.5 and 25.0 days for the early and late migrants respectively (Appendix Table i). The predicted study stock migratory peaks at each area are summarized in Table 3 of the text.

Appendix Table i. Summary of migration timing for the Harrison, Vedder, and Stave River chum salmon stocks (from Palmer 1972).

MIGRATION		MMEAN TRAVEL TIME
FROM	TO	(days)
Johnstone Strait	Cottonwood Drift	20.5[1] (25.0)[2]
Fraser Estuary (Buoy 18)	Silverdale	3.0 or 13 mi/day
Silverdale	Harrison Dead Recovery	20.4[3] (23.8)[4]
Silverdale	Vedder Dead Recovery	21.8[3] (23.6)[4]
Silverdale	Stave Dead Recovery	19.25
Harrison tagging site	Dead Recovery	11.0
Vedder tagging site	Dead Recovery	19.5
Stave tagging site	Dead Recovery	08.25

1. Tagged in Johnstone Strait prior to October 15
2. Tagged in Johnstone Strait after October 15
3. Tagged at Silverdale prior to November 15
4. Tagged at Silverdale after November 15

Appendix Table ii. Timing of migration between Silverdale tagging site and dead recovery for three major Fraser River chum stocks (after Palmer). Note: when two figures are reported, the first refers to chum tagged at Silverdale prior to November 15, the second (bracketed) figure refers to those tagged after November 15.

System	Time Out from Silverdale to Dead Recovery[1] (days)	Estimated Travel Time @13 mi/day[1] (days)	Average Redd Life[1] (days)	Estimated holding Time[2] (days)
Harrison River	20.4 (23.8)	2.3	11.0	7.1 (10.5)
Vedder River	21.8 (23.6)	1.2	19.5	1.1 (2.9)
Stave River	19.25	0.2	8.25	10.8

1. From Palmer (1972).
2. Time out from Silverdale minus mainstem travel time and average redd life.

ERRATA

1. TABLE OF CONTENTS should read:

Chum Salmon ---------- 6
Migratory Timing ---------- 6
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Chinook Salmon ---------- 8
Spawning Escapements and Timing ---------- 8
Age, Length and Sex Composition ---------- 8
Upper Pitt River Chinook ---------- 8

2. Page 53 should include the following table:

Table 3 (b). Age, mean postorbital-hypural plate length, and sex composition of 1977 and 1978 Kawkawa Creek chum salmon.

Age	Sex	1977			1978		
		Mean Length (mm)	N	%	Mean Length (mm)	N	%
5	Male	610	1	3.2	-	0	-
	Female	604	3	9.7	-	0	-
4	Male	596	11	35.5	585	59	56.7
	Female	583	13	41.9	567	39	37.5
3	Male	551	2	6.5	527	3	2.9
	Female	585	1	3.2	527	3	2.9
Combined	Male	591	14	45.2	582	62	58.5
	Female	587	17	58.7	566	44	41.5